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UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Survey

of

Garfield County, Nebraska

By

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Nebraska Soil Survey

and

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United States Department of Agriculture

Bureau of Chemistry and Soils

In cooperation with the
University of Nebraska State Soil Survey
Department of the Conservation and Survey Division

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SOIL SURVEY OF GARFIELD COUNTY, NEBRASKA

By BASIL ABASKIN, in Charge, E. A. NIESCHMIDT, and R. H. LOVALD, Nebraska Soil Survey, and F. A. HAYES, United States Department of Agriculture

COUNTY SURVEYED

Garfield County, Nebr., is a little northeast of the center of the State (fig. 1). It is 24 miles square and comprises 575 square miles, or 368,000 acres. Burwell, the county seat, is about 150 miles by rail northwest of Omaha.

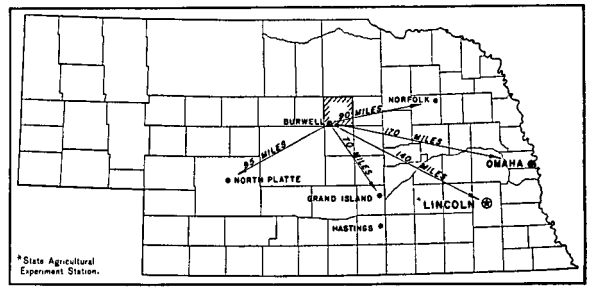

FIGURE 1.—Sketch map showing location of Garfield County, Nebr.

The general physiography of the county is that of a rolling or hilly plain interspersed in places by nearly level areas. The surface features have resulted mainly from the action of wind and water. The smoother areas are most extensive in the alluvial lands, but they occur here and there throughout the uplands in places where erosion has been least active. About 90 square miles in the southern part of the county is mantled to various depths by light-gray limy and floury silt, known as Peorian loess. The boundary between this section and the sand-hill section is very irregular. It is characterized by numerous tongues and isolated outliers of both silt and sand and by areas in which the loess has been buried by wind-blown sandy materials.

The mantle of loess, a few miles back from its northern edge, is not modified, except in a few places, by sandy deposits, but it has been subjected to rather severe water erosion. It is cut through in the southwestern part of the county by North Loup River, which has developed its flood plain on underlying sands. Smaller drainageways, chief among which are Bean and Haskell Creeks, together with their tributaries, ramify nearly all parts of the loess-covered uplands, producing a generally rolling to hilly relief with several areas of rough and broken land. A few of the divides have flat tops which are at or near the former level of the loess mantle, and most of them are less than three-eighths of a mile wide. The greater part of the land surface has been lowered considerably by geologic erosion. The loessial mantle is thickest in the extreme southern part of the county where some of the divides are from 60 to 120 feet above the valley floors. It becomes thinner northward and generally is not more than 20 feet thick at its northern edge.

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The rest of the county, including over 80 percent of the total area, is a part of the vast sand-hill section of north-central Nebraska. Here the surface features are largely the result of wind action on loose sand and consist of a succession of irregularly distributed wind-formed hills and ridges, ranging from 10 to 80 feet in height. Some of the hills are capped by drifting sand and pitted by blow-outs. The billowy surface is relieved here and there by nearly level or gently undulating valley floors, together with basins of various sizes, many of which include farming and hay land. Surface drainage channels are not established in the sand hills, except along Cedar River and some of its tributaries. The outlets of most of the valleys and basins are obstructed by sand dunes, and the surplus surface moisture escapes mainly through the porous substratum. In some places, water accumulates in the lower lying basins or parts thereof, creating patches of marshy land and shallow lakes, especially in Kinkaid Precinct.

Alluvial lands, which include the terraces and flood plains along the larger streams, occupy about 8 percent of the total land area. The largest developments occur as continuous strips along North Loup, Cedar, and Calamus Rivers and some of their tributaries.

The flood plains, or bottom lands, are broadest along North Loup River where they are from one-fourth to three-fourths of a mile wide. Broad but not continuous strips are along Cedar River and Little Cedar River, and narrow strips border Calamus River. The flood plains occupy the lowest positions and are subject to overflow during high stages of the streams. Their surfaces are nearly level, modified in places by abandoned and active stream channels, slight elevations, and shallow depressions.

The terraces are most extensive in the North Loup Valley where they lie from 7 to 40 feet above the normal level of the stream and are not subject to overflow from the main channel. They have nearly level or gently undulating relief, except where the terrace material is composed largely of incoherent sand and has been subjected to slight wind action.

The average elevation of Garfield County is about 2,300 feet above sea level. The highest point is probably on the sandy uplands in the west-central part, and the lowest is in Cedar River Valley at the eastern county line. The elevation of Burwell is 2,182 feet above sea level.[1] At Dumas the elevation is 2,200 feet.[2] The general slope is to the south and east.

Drainage is effected through North Loup and Cedar Rivers and their tributaries, of which Calamus River, Little Cedar River, and Dry Cedar Creek are the largest. North Loup and Calamus Rivers are permanent streams. Cedar River and Pebble Creek flow permanently in their lower courses. The other streams are intermittent. Most of the drainageways in the loessial uplands are rapidly deepening and widening their valleys.

Well water of good quality is readily obtained in most sections. Wells throughout the higher parts of the sand hills and in the loess-covered areas range from 80 to 270 feet in depth. Water in the allu-

[1] GANNETT, H. A DICTIONARY OF ALTITUDES IN THE UNITED STATES. U. S. Geol. Survey Bull. 274, ed. 4, 1072 pp. 1906.
[2] U. S. Weather Bureau station.

vial lands and in some valleys in the sand hills is obtained at depths ranging from 10 to 80 feet. Flowing or artesian wells are in the north-central part of the county. These have sufficient pressure to lift the water from 1 to 3 feet above the surface of the ground.

Native broad-leaved trees, principally willow, ash, elm, boxelder, and cottonwood, grow in narrow strips on the alluvial lands and in planted groves on the upland. The trees are not used for lumber but are of local value for posts and fuel. The native grasses, where not destroyed by cultivation, consist largely of blue grama and needlegrass in the loess-mantled section. Sand reedgrass, hairy grama, and little bluestem are dominant on the soils of the sandy uplands. In the bottom lands sloughgrass, big bluestem, Indian grass, switchgrass, and other high-moisture requiring species grow luxuriantly.

Garfield County was organized from the western half of Wheeler County in 1884, and its boundaries have remained unchanged. The first permanent settlement in the area now included in the county was made in 1872 on the east side of North Loup River in sec. 19, T. 21 N., R. 15 W. This location is known as Willow Springs.

According to the Federal census, the county had 3,207 inhabitants in 1930, all classed as rural. The average density of the population is 5.6 persons a square mile. The population is densest in the loess-covered part of the uplands and in the valleys of the larger streams, but the sand-hill section is rather sparsely settled.

Burwell, in the southwestern part, is the only town in the county. It had a population of 1,156 in 1930. This place is a local market for farm implements, supplies, and produce. A cooperative creamery and a grain elevator are located here.

Transportation facilities are fair. The only railroad is a branch of the Chicago, Burlington, & Quincy, which terminates at Burwell. A gravel-surfaced State highway extends north and south and a graded earth highway east and west across the county. Burwell is on both roads. The county roads are of earth construction. Most of them follow section lines, except in the rougher areas where they conform to the topography. Good roads are scarce throughout the sand hills, where most of the travel is on trails that follow the courses of least relief.

Mail routes reach nearly all sections, and telephones are in common use. The public-school system is well developed.

CLIMATE

The climate of Garfield County is continental and of the mid-latitude temperate type. There are rather wide variations in temperature between winter and summer, but the climate is favorable for the production of grain, vegetable, and hay crops and for the raising of livestock. The springs are cool, with considerable rainy weather which favors rapid growth of the pasture grasses. The summers are long, with warm days and nights, which are especially favorable for the growth of corn and alfalfa. The autumns are long and pleasant, with only occasional periods of rainy weather, thus giving the farmer ample time to harvest the corn crop. Low temperatures occur during the winter but are usually accompanied by

snow which moistens the surface of the ground and assists in preventing the soil from drifting.

The greater part of the summer rainfall comes during local thunderstorms. The mean annual precipitation, when normally distributed, is sufficient for successful farming without rigid adherence to dry-farming methods. In May and June, periods of drought are uncommon; in July, the distribution of the rainfall is less favorable; and during August and September, long periods of drought sometimes cause reduced yields of grain and hay. Total crop failures, however, are rare.

The average date of the last killing frost is May 7 and that of the first is October 4. This gives an average frost-free season of 150 days which is ample for the maturing of all the crops commonly grown. Killing frost has been recorded as late as May 24 and as early as September 18.

During most of the year the prevailing winds are from the northwest, but in June, July, August, and September they are mainly from the south and southeast. Strong winds are common, but tornadoes are rare.

Table 1, compiled from records of the Weather Bureau station at Dumas, in the northeastern part of the county, gives the normal monthly, seasonal, and annual temperature and precipitation for that place. These data are fairly representative for the county as a whole.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Dumas, Garfield County, Nebr.*

[Elevation, 2,200 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1934)	Total amount for the wettest year (1920)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	23.4	73	−29	0.56	0.75	0.64	3.2
January	20.6	69	−30	.40	.30	(1)	2.5
February	25.4	69	−31	.61	.70	.50	5.7
Winter	23.1	73	−31	1.57	1.75	1.14	11.4
March	33.6	80	−19	.88	.80	.74	7.3
April	46.9	87	3	2.12	.50	9.58	3.6
May	57.1	97	22	3.59	1.61	5.86	0
Spring	45.9	97	−19	6.59	2.91	16.18	10.9
June	66.7	100	33	3.46	2.94	5.66	0
July	72.8	104	39	2.80	.88	2.65	0
August	71.2	106	36	2.94	.75	4.40	0
Summer	70.2	106	33	9.20	4.57	12.71	0
September	62.0	98	19	2.11	2.30	.90	1.7
October	50.1	91	3	1.46	.20	1.68	2.0
November	36.4	82	−10	.83	.98	1.65	3.6
Fall	49.5	98	−10	4.40	3.48	4.23	7.3
Year	47.2	106	−31	21.76	12.71	34.26	29.6

[1] Trace.

AGRICULTURE

Prior to the first settlement in 1872, the area now included in Garfield County was occupied by Indians and trappers, who subsisted largely on wild game, fish, and fruit. The earliest settlers located in the larger valleys where fuel and water were readily obtained and where the land surface favored easy tillage. Corn and garden vegetables, usually the first crops planted, together with game and beef, formed the chief foods. By 1890 most of the valley lands and the more nearly level areas of the loess-covered uplands were under cultivation. The more stable parts of the sandy uplands have been added gradually to the cultivated acreage. By far the greater part of the county, however, is too sandy and unstable for tame-hay and grain crops, and it still remains with its virgin cover of grasses. It is used almost exclusively for grazing and wild-hay land, in connection with cattle raising which is the leading source of income.

Of the cultivated crops, corn has occupied the largest acreage since farming began. The area devoted to this crop, however, has always been exceeded by that used for pasture land and, except prior to about 1900, by that used for the production of wild hay. During all except a few years, oats, which are needed as feed for livestock, have ranked next to corn in acreage. The area used for rye has gradually increased as more of the sandy lands have been brought under cultivation. Wheat is grown only as a cash crop, and during most years it ranks next to oats in acreage. No cultivated crop is grown so extensively in this county as in counties having less sandy land. According to the Federal census there were 118,283 acres, or about 32 percent of the county, in cropland during 1935.

Most of the farms and ranches range in size from 260 to 1,000 acres, but there are many smaller holdings. There were 499 farms, including 91.8 percent of the county in 1935, and the average size was 677 acres.

Farm improvements are fairly good. The houses, as a rule, are one-story wooden structures, most of which are kept in good repair. Some sod houses are still standing, but only a few are occupied. On most farms the barns and other outbuildings are large enough to house the work animals, hogs, and milk cows and to store all the feed except the hay and other roughage, which are stacked in the field. Most of the farms are fenced and cross fenced. In the rougher and more sandy sections, where the land is suitable only for grazing purposes, the ranches have few cross fences.

The work animals are mainly heavy draft horses and mules. Lightweight saddle horses are kept on all cattle ranches. Some farmers use trucks and tractors for the heavier farm work.

According to the Nebraska agricultural statistics, 17 farmhouses had modern heating plants, 109 had running water, 32 were equipped with electricity, and 160 had radios in 1930. The same authority reports 49 tractors, 72 gas engines, 80 trucks, 379 automobiles, 20 grain threshers, and 2 combines on the farms during that year. The farm machinery is of the most modern and labor-saving types. It includes complete equipment for harvesting hay.

Most farmers and ranchers do their own work except in the haymaking season when much help is hired. Farm labor during the last few years has been plentiful and cheap. Monthly wages range from $15 to $20 with board and lodging. Day labor has recently been plentiful at $1. Little help was hired in 1934, as the severe drought in that year resulted in greatly reduced crop yields.

The Federal census reports owners on 46.3 percent of the farms, tenants on 52.7 percent, and managers on 1 percent in 1935. The proportion of tenant-operated farms has gradually increased since the county was established.

The Nebraska agricultural statistics show that 46 percent of the rented farm acreage was rented for cash and 54 percent for a share of the crops in 1930. Under the cash system, the renter pays from $2 to $5 an acre for the better grade of farming land and from $100 to $150 a section (640 acres) for pasture land. Under the share system, the tenant generally furnishes all labor, seed, and machinery and receives two-thirds of the grain and one-half of the hay.

The Federal census reports the average value of land and buildings as $8.03 an acre in 1935. The selling price of individual farms and ranches ranges widely, depending on the soils, relief, drainage improvements, and location with respect to markets. The highest priced land is in the North Loup Valley in the vicinity of Burwell.

As has been stated, the raising of livestock is the most important industry. The value of all domestic animals on farms on April 1, 1930, was $1,067,249, and that of all crops, including forest products for home use and sale, was $601,712.

Table 2, compiled from the Federal census reports, gives the number and value of all domestic animals and poultry in this county in 1900, 1910, 1920, 1930, and 1935.

TABLE 2.—*Number and value of domestic animals and poultry in Garfield County Nebr., in stated years*

Livestock	1900		1910		1920		1930		1935	
	Number	*Dollars*	*Number*	*Dollars*	*Number*	*Dollars*	*Number* [1]	*Dollars*	*Number*	*Dollars* [2]
Cattle	14,724	----	16,090	367,905	16,759	856,899	15,616	799,621	15,757	----
Sheep	4,360	----	40	211	687	7,816	825	6,112	523	----
Goats	----	----	29	139	6	36	46	239	22	----
Swine	5,648	----	8,098	77,240	9,537	179,230	9,214	117,818	3,417	----
Horses	2,115	----	4,093	370,047	4,300	253,784	3,260	127,978	3,342	----
Mules	84	----	276	27,439	298	27,747	313	15,331	200	----
All poultry	14,107	6,036	26,896	12,381	34,522	27,182	[3] 29,416	22,356	27,010	----

[1] Number on farms and ranges only.
[2] Value not reported.
[3] Chickens only.

The cattle are of good quality. Nearly all of them are grades, but the herds are usually headed by a purebred Hereford or Shorthorn bull. Practically all the beef cattle are raised locally. In the sandhill parts of the county, most of the cattle are sold as feeders when 2 or 3 years old, after coming off summer range. In the loess-covered areas, where the soils favor the growing of grain, some farmers fatten cattle on corn and alfalfa before shipping them to market.

Dairy products are an important source of income. Most ranchers and farmers keep from 4 to 8 cows, chiefly of mixed beef and dairy breeds. Much of the surplus cream is handled in a cooperative creamery located at Burwell. No farm is devoted exclusively to dairying. The 1930 Federal census reports $146,315 as the value of dairy products and butter in 1929.

Horses are raised in large herds by several ranchers in the sand hills, and they rank next to cattle in total value. Most of the horses are of grade stock, sired by purebred Percheron stallions. The horses not needed in the county are sold to farmers in southern and eastern Nebraska.

Hog raising is an important branch of livestock farming. Most of the hogs are raised on the finer textured soils in the southwestern part of the county and on the better drained parts of the bottom lands, where corn and alfalfa can be grown. Each farmer raises a few hogs, and some maintain large herds. Many hogs are raised in connection with the feeding of beef cattle. Most of them are fed corn and alfalfa or sweetclover, and the young pigs usually receive some rye, oats, and barley. The hogs are of good breeding, and there are many purebred herds of Duroc-Jerseys, Poland Chinas, and Hampshires.

Sheep raising does not receive much attention. A few farmers graze sheep on the rougher parts of the loessial uplands in the southwestern part of the county. Hampshire and Shropshire are the leading breeds.

Poultry and poultry products are produced for sale and home consumption, and poultry raising is receiving increased attention. Chickens are raised on every farm, and most farmers have large flocks. Plymouth Rock, Leghorn, and Rhode Island Red are the leading breeds. Turkeys are raised in large or small flocks by a few farmers and locally are an important source of income. Ducks, geese, and guinea fowls are raised to a small extent. The 1930 Federal census reported the value of poultry and eggs in this county as $91,614 in 1929.

The farming practices on the different kinds of land in Garfield county do not differ materially from those on similar land in other counties of north-central Nebraska. Nearly all of each crop produced, except wheat, which is grown for cash, is used locally for livestock feed or for consumption in the home. Some of the wild hay is baled and shipped to outside markets, but most of it is used on the farms where produced or is sold directly from the stacks to local cattlemen. This crop, which occupies a larger area than that of all tame-hay and grain crops combined, is followed by corn, oats, wheat, alfalfa, and rye, ranking in acreage during most years in about the order named. None of the planted crops, except corn, occupies more than a few thousand acres and during some years only a few hundred acres.

Crop yields vary greatly from place to place, according to variations in the soil and in the amount and distribution of the precipitation. The average annual yield of each crop for the county, as a whole, however, remains fairly uniform.

Table 3, compiled from Federal census data, gives the acreage devoted to the leading crops in 1889, 1899, 1909, 1919, 1929, and 1934.

TABLE 3.—*Acreage of the leading crops in Garfield County, Nebr., in stated years*

Crop	1889	1899	1909	1919	1929	1934 [1]
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn	9,542	10,472	22,405	21,245	23,459	51
Oats	1,267	1,418	4,806	5,740	6,780	79
Wheat	961	8,697	3,099	4,430	511	10
Rye	293	193	546	2,918	1,794	155
Barley	49	47	149	311	552	----------
Potatoes	245	153	640	153	187	84
Tame hay	[2] 7,744	379	4,200	6,868	4,844	[2] 55,821
Wild hay	----------	7,968	38,173	51,193	49,831	----------
Sweetclover [3]	----------	----------	----------	----------	858	(4)

[1] On account of the drought in 1934, the acreage of all crops was greatly reduced.
[2] All hay.
[3] For pasture only.
[4] Not reported.

Table 4, compiled from the Nebraska agricultural statistics, shows the average acre yield of the more important crops during the 5-year period 1925–29, the average yield in 1930, and the approximate percentage of the land devoted to each crop in 1930.

TABLE 4.—*Average acre yield of the more important crops in Garfield County, Nebr., during the 5-year period, 1925–29, the average yield in 1930, and the approximate percentage of the area devoted to these crops and other uses in 1930*

Crop	Average acre yield		Approximate area in crop in 1930	Crop	Average acre yield		Approximate area in crop in 1930
	1925–29	1930			1925–29	1930	
	Bushels	*Bushels*	*Percent*		*Tons*	*Tons*	*Percent*
Corn	20.4	24	6.3	Wild hay	0.74	0.8	12.2
Winter wheat	14.8	16	.08	Alfalfa hay	2.06	2.6	.7
Spring wheat	12.0	14	.09	All tame hay	1.90	2.1	1.4
Oats	24.6	29	1.5	Range and pasture	----------	----------	51.1
Barley	24.0	27	.3				
Rye	12.6	16	.7				
Potatoes	66.2	67	.06				

Corn, the most important cultivated crop, is planted about the end of May. A lister is ordinarily used, because a minimum of labor is required in preparing the land. The corn is cultivated three or four times until late in July, after which it receives no further attention until harvest, except to remove the more obnoxious weeds by hoeing. The crop matures early in October, and the greater part is husked from the standing stalks. On some farms corn is grown on the same land 4 or 5 years, consecutively, but better yields are obtained where the crop is grown in rotation with small grain and alfalfa. In recent years some attention has been given to the improvement of the seed corn, but as a rule, selection of seed is not carefully practiced. The Holdrege and Marshall soils of the uplands and the Hall and Waukesha soils in the valleys produce the highest yields. Most of the corn is fed to hogs, cattle, and work animals, especially on farms operated by owners.

Oats are grown on all the improved soils, but they are not so well adapted to the sandier land as corn, on account of their shallower root systems and the danger of injury to the young plants by drifting sand. They are seldom grown two consecutive years on the same land. Oats are frequently used as a step in the rotation between corn and rye, wheat, or barley. Most of the seed is obtained by cleaning a part of the previous crop, but some is imported from other sections. Little effort is made to control smut, although this disease lowers oat yields considerably in some years. The grain is fed chiefly to work animals, and the straw is used for roughage.

Rye is adapted to a greater variety of soils than the other small-grain crops and is planted in small fields throughout all parts of the county, except those occupied by the more poorly drained soils or by dune sand. It is generally grown for the grain but to some extent for temporary fall and spring pasture. Rye is more drought resistant than the other small-grain crops and will flourish on soils of a more impoverished nature. Much of it is grown on the Valentine and Thurman soils and on the sandier types of the Marshall soils. The seed is planted with a press drill early in April. The grain matures in July and is cut with a binder or header. It is threshed from shocks or from stacks. It is all fed locally, chiefly to hogs.

Wheat is not grown extensively, mainly on account of the sandy character of most of the soils. Both winter and spring varieties are grown. Winter wheat can be sown in the fall at a time when farm work is light, and it matures before dry weather and hot winds occur. There is some danger of winter-killing. In wet seasons, smut damages both winter and spring wheats. Rust rarely injures winter wheat, but it may damage spring wheat if the season is unusually moist. Wheat is planted and harvested in the same manner as rye.

Barley usually does not occupy more than 500 acres a season. This crop, although nearly as valuable as corn or oats for feeding purposes, is poorly adapted to sandy soils, and it has never been grown extensively.

The wild hay is produced chiefly on land that is too rough, sandy, or poorly drained for cultivated crops. Some of the bottom lands near the headwaters of Cedar River and along Little Cedar River are too wet for cultivation, but they support a rank growth of grasses which yield about a ton of hay to the acre. High acre-yields of wild hay are obtained in the more poorly drained parts of the bottom lands along North Loup and Calamus Rivers. Much wild hay is cut in the wet valleys and on the more nearly level areas throughout the sand hills. The highest yields are obtained on the poorly drained soils of the alluvial lands, but the hay from the uplands grows less rank, is of finer texture, and has a higher feeding value.

Among the tame-hay crops, alfalfa has attained considerable importance in the last three decades. The area devoted to this crop has fluctuated only slightly during recent years. Alfalfa does well on most of the finer textured and well-drained soils but is not so well adapted to the more sandy lands, except in localities where the

moisture supply is unusually favorable and where soil drifting is controlled until the plants are well established. The seed is sown, usually in the spring, on plowed and harrowed land. Occasionally a nurse crop of oats or barley is sown with the alfalfa. The main consideration in obtaining a stand is thorough preparation of the seedbed. A stand of alfalfa is allowed to remain as long as the yield is satisfactory. The crop is usually cut three times during the summer season. The hay is stacked in the field, is hauled to the feed lots as needed, and is fed to cattle and hogs. On many farms green alfalfa is an important hog feed. Cattle, however, are seldom allowed to graze on it on account of the danger of bloating. Alfalfa not only has a high nutritive value and yields well, but it is valuable in increasing the productivity of the soil for grain crops.

Mixed stands of timothy and clover are grown on many of the bottom-land farms in the North Loup, Calamus, and Cedar River Valleys. A mixture of timothy and clover is grown on some farms for hay which is fed to work animals and cattle. This crop is well adapted to the moist soils of the bottom lands where drainage conditions are unfavorable for the production of grain.

Sweetclover, although still a minor crop, is grown to a greater extent each year. It is used chiefly for pasture and to some extent for hay and seed. This plant is a biennial and dies at the end of the second year, after producing seed. It is used chiefly for pasture in this county. When hay is desired, the crop is cut during the first year before the growth becomes coarse. In the second year, the crop may be allowed to mature and reseed itself or it may be cut with a binder and threshed for seed. The most common time of seeding is in early spring. The seed is usually broadcast and covered with a harrow. Most of the sweetclover is grown on rather sandy land. This crop thrives on either comparatively wet or dry soils and on those of heavy or light texture. The roots are large and vigorous and decay rapidly after the end of the second year's growth. Sweetclover is especially valuable on unstable sandy soils and on steep slopes where erosion is severe.

There are several small farm orchards, but the demand for fruit is not supplied and orcharding, especially on the soils of the terraces, could be profitably extended. Apples, plums, and cherries are the most important cultivated tree fruits. Orchards do not thrive so well on the uplands as on the terraces.

Commercial fertilizer is not used in this county. Barnyard manure is applied when available, but the supply is seldom sufficient to have much effect on crop yields.

No definite system of crop rotation is practiced. On some farms corn or wheat has been grown continuously for 6 or more years on the same land. Corn is usually grown 4 or 5 years, followed by oats 1 year, and wheat 2 or 3 years, after which the land is again used for corn, or is planted to rye or barley. Leguminous crops are seldom used in the rotations, except on the bottom lands and terraces, where considerable alfalfa is grown, and on some of the sandy uplands where sweetclover is produced. On tenant farms the rotation is governed more by the demand and price of the grain products than by the requirements of the soil.

More than 70 percent of the county, including all the rougher and more sandy areas, remains with its native grass cover and is used for grazing land. The grasses on the finer textured soils of the uplands will support from 100 to 125 head of cattle a section (640 acres) during the summer grazing season, May to October, inclusive. In the sand hills from 70 to 90 cattle are allowed for each square mile. The utilization of the sandy grazing land depends mainly on the preservation of the rather sparse grass cover.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers or horizons called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [3] and its content of lime and salts are determined by simple tests. The drainage, both internal and external, and other external features, such as the relief or lay of the land, are taken into consideration, and the interrelation of soil and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics soils are grouped into classification units. The three principal ones are: (1) Series, (2) type, and (3) phase. There are areas of land, such as dune sand or rough broken land, which are not true soils; and these are called (4) miscellaneous land types.

The most important of these groups is the series which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics, and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Thus Holdrege, Hall, and O'Neill are names of important soil series.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Holdrege silt loam and Holdrege very fine sandy loam are soil types within the Holdrege series. Except for the texture of the surface soil these soil types have

[3] The reaction of the soil is its degree of acidity or alkalinity, expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values alkalinity, and lower values acidity.

approximately the same internal and external characteristics. The soil type is the principal unit of mapping and because of its specific character is generally the soil unit to which agronomic data are definitely related.

A phase of a soil type is recognized for the separation of soils within the type, which differ in some minor soil characteristic that may, nevertheless, have important practical significance. Differences in relief, stoniness, and degree of accelerated erosion are frequently shown as phases. For example, within the natural range of relief for a soil type, there may be parts which are adapted to the use of machinery and the growth of cultivated crops and other parts which are not. Even though there may be no important differences in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated plants. In such an instance the more sloping portions of the soil type may be shown on the map as a sloping or hilly phase. Similiarly soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, complexes, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other cultural and natural features of the landscape.

SOILS AND CROPS

The farming system in Garfield County, as a whole, is dominated by livestock raising because of the extensive rough or sandy areas which are suited only for grazing and wild-hay land.

As previously indicated, practically all of the relatively small amount of arable land, except that which is devoted to wheat, is used for feed crops. Of these corn occupies the leading acreage, partly because of its high feed value but mainly because it can adapt itself to a wider range of soil conditions than can most of the other indigenous grains. The varieties, yields, and acreage ratios of the crops, however, and the practices followed in growing these crops vary on different farms according to differences in the character and distribution of the soils.

More than 80 percent of the uplands are covered by extremely sandy material on which true soils have developed only in the lower or more level situations where the sand has been least affected by wind action. In these situations the soils have accumulated more or less organic matter, the amount depending on the moisture conditions and the luxuriance of the grass cover under which they have developed. In some of the more drepressed and poorly drained areas the topsoils contain such large amounts of decayed vegetal remains that they are almost black and, to a depth of 8 or 10 inches, have a spongy character and an appreciably light weight. Such soils are unsuited for cultivation and are used almost exclusively for the production of wild hay.

In the better drained valleys and pockets and on flats, decayed grass remains, although less abundant than in poorly drained areas, have greatly darkened the surface layers of the sandy soils. Here

the topsoils are fairly stable even under cultivation, provided ordinary care is exercised to retard wind erosion. These soils, the combined acreage of which is rather large, are used chiefly for corn, rye, and sweetclover. Alfalfa is occasionally grown on them, but they are a little too loose and droughty in the upper soil layers for good yields of wheat and oats.

In the higher lying and more rolling and hilly areas the sand supports a comparatively sparse cover of grass and has accumulated very little organic matter. Most of the land in these areas is too unstable for cultivation. It is used mainly for grazing purposes and the production of wild hay.

Few of the sandy soils contain lime, and some of them are rather low in both phosphorus and nitrogen. Unless they are carefully managed, their content of organic matter decreases rapidly under cultivation.

Throughout the loessial uplands in the south-central and southwestern parts of the county, the soils have developed from silty material. These soils are fine textured and are relatively much more stable against wind erosion than the soils that have developed from sand. They do not absorb moisture quite so rapidly as more sandy soils, and for this reason a little more of the precipitation is lost through run-off and evaporation before it can penetrate deeply. They have, however, much greater moisture-holding capacities than sandy soils and hold a higher percentage of the moisture in the upper part of the soil profile where it is of most value to crops. All the silty soils are friable, well aerated, and afford easy penetration for roots. They contain plenty of lime for crop needs, although the amount of this material and its depth beneath the surface vary somewhat in different localities. Where not severely eroded, these soils have thick almost black surface layers, are deeply developed, and are among the most productive soils in this part of Nebraska for corn, small-grain, and tame-hay crops. In Garfield County, however, much of the area occupied by the silty soils has suffered such severe water erosion during past geologic times that it is of value mainly for grazing land. All crops indigenous to the section are grown with good yields on the less eroded divides and more gradual slopes, but elsewhere the topsoils have never developed or have been seriously thinned or entirely removed by erosion, and the light-colored limy parent silt is exposed at numerous places. This silty material is, in itself, very productive, especially for alfalfa and sweetclover, but most of it is so steeply sloping or severely gullied that it cannot be cultivated. Some wild hay is cut in the eroded areas.

In addition to the silty and sandy soils, the uplands include numerous small areas where the soils have developed from thin deposits of silt over sand and vice versa, and from rather uniformly mixed silt and sand deposits. Several of these soils have accumulated considerable organic matter, have very dark surface layers, and are fully as stable as any silty soil in the county. They are used chiefly for corn, oats, and wheat. Others are barely stable enough for corn and sweetclover, and some have such loose, incoherent, and light-colored topsoils that they are suited only for grazing purposes and the production of wild hay.

The alluvial lands include a variety of nearly level soils which have developed from stream-laid sediments on the terraces and bottom lands. These soils, with few exceptions, have thick dark surface layers which are well supplied with organic matter and are not subject to injurious erosion by either wind or water. They all receive some moisture through run-off from higher land. Those on the bottom lands are subject to overflow during flood stages of the streams but are not, as a whole, too poorly drained for crops. Those occupying terrace positions are well drained at all times.

The darker soils of the alluvial lands are the strongest and most productive soils for corn and alfalfa in the county. The more silty soils on the terraces also give higher yields of small-grain crops than any other soil. A few light-colored extremely sandy and unstable soils, however are on the terraces and bottom lands within the county. These soils, together with local poorly drained or slightly alkaline patches of associated heavier soils, are included in hay and pasture land.

In this report the individual soils of the county are combined on the basis of the crops for which they are most extensively used and for which they give the largest returns under the present farming system, into four broad groups, namely: Soils best suited to corn, oats, and wheat; soils best suited to corn, rye, and sweetclover; soils best suited to corn and alfalfa; and soils best suited to native pasture and hay grasses, respectively. By this grouping it is not intended to imply that the crops mentioned in connection with any particular group are the only ones which can be grown on the soils of that group. Under a more intensive farming system including, where necessary, artificial drainage, incorporation of organic matter, and control of wind and water erosion, most of the indigenous crops could be successfully grown on nearly all of the soils.

The placing of the soils in the groups mentioned is based not only on the soil and crop adaptations but also on those soil characteristics which are responsible for these adaptations and on the natural surface features and drainage conditions. Some of the soils in each group are of very local occurrence.

In the following pages the various soils in the different groups are described, and their crop adaptations are discussed; the soil map accompanying this report shows the distribution of the soils in the county; and table 5 gives their acreage and proportionate extent.

SOILS BEST SUITED TO CORN, OATS, AND WHEAT

The soils classed in this group include the Marshall and Holdrege soils of the uplands and the Hall and Waukesha soils on the terraces. These soils have nearly level or rolling surfaces, have been subjected to relatively slight erosion by either wind or water, and have accumulated an abundance of well-decomposed vegetal remains. They have very dark, in places almost black, topsoils ranging from about 10 to 16 inches in thickness. The subsoils contain sufficient silt to give them good coherence in the upper part, and most of them are composed largely of this material throughout. The soils are highly retentive of moisture, are well drained, and are stone free. They are friable and are easily maintained in good tilth. They all

contain enough lime for crop needs, although in some the lime is much less abundant than in others.

The soils of this group are well adapted to any crop commonly grown in the county. Nearly all of the area occupied by them, aside from that included in farmstead sites and small pastures for the work animals and milk cows, is under cultivation. Corn, oats, and wheat are the principal crops, although a considerable acreage on the terraces is in alfalfa. Rye and sweetclover occupy only small fields on these soils.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Garfield County, Nebr.*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Holdrege silt loam	5,952	1.6	Sparta sand	5,504	1.5
Holdrege very fine sandy loam	4,480	1.2	Cass loamy fine sand	28,992	7.9
Marshall very fine sandy loam, sandy-substratum phase	1,792	.5	Cass fine sandy loam	3,008	.8
Marshall fine sandy loam, sandy-substratum phase	5,056	1.4	Cass very fine sandy loam	2,304	.6
Hall silt loam	3,840	1.1	Lamoure silt loam	512	.1
Hall very fine sandy loam	1,792	.5	Dune sand	159,488	43.3
Waukesha silt loam	1,408	.4	Valentine fine sand	98,688	26.8
Waukesha very fine sandy loam, sandy-substratum phase	4,032	1.1	Valentine loamy sand	4,096	1.1
Thurman loamy fine sand	9,536	2.6	Gannett loamy sand	384	.1
Thurman fine sandy loam	2,176	.6	Sarpy sand	256	.1
Anselmo loamy fine sand	2,496	.7	Colby silt loam	4,928	1.3
Anselmo fine sandy loam	832	.2	Colby very fine sandy loam	3,008	.8
O'Neill loamy fine sand	2,752	.8	Rough broken land (Colby soil material)	9,536	2.6
O'Neill fine sandy loam	1,152	.3	Total	368,000	

Crop yields are rather uniform. Some of the soils produce a little higher than others, but this is owing to differences in the relief, particularly the slope of the land and its elevation with respect to surrounding areas, rather than to differences in the soils themselves. Ordinarily the soils occupying upland positions have more sloping surfaces than those on the terraces, and they suffer greater loss of moisture through run-off. In addition, they are not so favorably situated to receive moisture from higher levels and are naturally a little less productive than the soils of the benches.

Holdrege silt loam.—Holdrege silt loam, which is the most extensive soil of the group, occupies only 5,952 acres. It covers several irregular-shaped areas of various but mostly small sizes on the loess-covered uplands in the southern and southwestern parts. The soil occurs chiefly on nearly level to rolling remnants of the original loess plain. Both surface drainage and underdrainage are well developed. The soil is not subject to destructive erosion, except on the steeper slopes and around the margins of some of the areas where run-off is excessive. It occupies some of the highest positions in the county. The largest areas are in the south-central part of the county.

The topsoil, to an average depth of about 12 inches, consists of very dark grayish-brown mellow silt loam with a high content of organic matter. The upper part of the subsoil, which extends to a depth of about 2 feet, is light-brown moderately heavy but friable silt loam. The next, or third, layer is transitional in character between the layer above and the layer below. It is composed of floury

light grayish-brown silt containing only faint traces of organic matter. None of the layers described is sufficiently limy to produce effervescence when acid is applied. The fourth layer resembles the third in a general way, but it contains an abundance of lime in small soft or hard concretions and in finely divided form. It is characteristic of most fully developed soils of the subhumid section of the central and western parts of the United States. This layer is 12 or 14 inches thick, is generally lighter in color than any other layer, and, on account of its high lime content, is known as the lime horizon. Beneath the lime horizon is the light grayish-yellow silty and limy loess from which the soil has developed. The loess does not contain so much lime per unit of volume as occurs in the lime horizon.

Holdrege silt loam is remarkably uniform throughout its distribution. It includes a few minor variations, however, that are worthy of mention. On slopes, erosion has thinned the topsoil and the lime horizon lies a little nearer the surface of the ground than in the more nearly level areas. In places, all or nearly all the topsoil material has been removed. Where this condition occurs in areas of sufficient size to warrant mapping, the eroded soil is mapped as Colby silt loam. In an almost level area in the vicinity of McIntire School, the upper part of the subsoil is considerably more compact than that of the typical soil. Were this area larger, it would have been mapped as Hastings silt loam, but owing to its small extent it is included with Holdrege silt loam. The principal textural variation is toward very fine sandy loam, and small bodies having this texture may be included in places with the silt loam.

Holdrege silt loam is probably as strong and fertile as any soil on the uplands in the Mississippi Valley. Nearly all of it in Garfield County is under cultivation. Corn, oats, and wheat are the leading crops, and alfalfa occupies a rather large acreage.

Although very fertile this soil does not give as high yields as are obtained on the better soils of Iowa and eastern Nebraska, where the precipitation is greater. In seasons of high rainfall corn and alfalfa yield about twice as much as in normal years. The average yield of corn over a period of years is about 25 bushels an acre, and oats yield about the same as corn. Rye and wheat yield about 13 bushels an acre. Alfalfa during the first 3 or 4 years of the cropping period yields about 1½ tons of hay an acre each season. The yield of this crop gradually declines in succeeding years.

Cattle raising is not practiced extensively, as the soil is too valuable to be used as grazing land. Some farmers fatten cattle which are purchased from ranchers in the sand hills. These cattle are fed corn and alfalfa from 60 to 90 days and are then shipped to the Omaha market. Hogs are raised on nearly every farm, and some farmers have large herds.

Holdrege very fine sandy loam.—Holdrege very fine sandy loam occupies several scattered and mostly small bodies on the loessial uplands mainly in Willow Springs and Midvale Precincts. This soil occurs in close association with the silt loam, but it generally lies nearer areas of sandy soils.

This soil has a very dark grayish-brown surface layer from 10 to 14 inches thick, a friable dark grayish-brown upper subsoil layer and a light-colored floury and silty lower subsoil layer which con-

tains an abundance of lime. It has about the same surface features and drainage conditions as Holdrege silt loam and is similar to that soil in all profile features except the texture of the topsoil. Holdrege very fine sandy loam has a slightly more sandy topsoil than has Holdrege silt loam, but the sand is not sufficiently abundant to noticeably reduce either the stability or the moisture-holding capacity of the soil material.

The soil is well suited to any crop commonly grown, and nearly all of it is under cultivation. It is as productive as Holdrege silt loam, and the farmers regard both soils with about equal favor for general farming.

In a few small patches, not shown separately on the soil map, the surface layer contains a little more and coarser sand than typical and approaches a fine sandy loam in texture.

Marshall very fine sandy loam, sandy-substratum phase.—Marshall very fine sandy loam, sandy-substratum phase, occupies several small bodies and irregular-shaped strips, most of which are in Willow Springs and Midvale Precincts. The largest development, comprising about 400 acres, is 6 miles northeast of Burwell.

Areas of this soil are nearly level or gently sloping and, in places, slightly rolling. They are within the transitional zone between areas of the more silty and the more sandy soils and, therefore, have some characteristics of both. The material from which the soil has developed, however, is chiefly of a silty character.

The topsoil ranges from 10 to 14 inches in thickness and consists of very dark grayish-brown or almost black very fine sandy loam. It is rich in organic matter which accounts for its dark color. The subsoil is dark grayish brown in the upper part and light grayish brown in the lower part. It is composed mainly of very fine sandy loam with a relatively large proportion of silt. The average thickness of this layer is about 25 inches. The rest of the soil consists of very light grayish-brown silt loam or very fine sandy loam. This rests on gray sand, generally within a depth of 4 feet.

The soil is friable, retains moisture well, and is not subject to destructive wind or water erosion. It is all adequately drained.

It is low in lime, compared to the Holdrege soils, but does not seem to be deficient in this material so far as crop needs are concerned.

Nearly all of this soil is under cultivation, and corn, oats, and alfalfa are the leading cultivated crops, ranking in acreage, during most years, in the order named. A small acreage is devoted to rye, barley, and millet on most farms.

Crop yields are about the same as, or a trifle lower than, those obtained on Holdrege silt loam. Alfalfa produces as well as on any of the better soils of the uplands.

All crops are fed on the farms where grown, to cattle, work animals, and hogs, or are sold to local feeders.

Marshall fine sandy loam, sandy-substratum phase.—The 10- or 12-inch surface layer of the sandy-substratum phase of Marshall fine sandy loam is very dark grayish-brown fine sandy loam which contains a high percentage of very fine sand, is coherent and friable, and, except in a few places, has sufficient organic matter and silt to prevent destructive wind erosion when intensive cultivation is practiced.

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The subsoil consists of grayish-brown or light grayish-brown very fine sandy loam with a large proportion of silt. The upper part is considerably darker and a trifle heavier than the lower, but it is friable. About 30 inches below the surface of the ground the subsoil becomes very sandy and rests on loose gray sand within a depth of 4 feet.

The soil does not contain sufficient lime to produce effervescence when acid is applied, but no deficiency of lime is indicated by the crops. The content of organic matter decreases downward, and only faint traces occur below a depth of 2 feet. The principal textural variation is toward loamy fine sand, and small areas having this texture in the topsoil are included with mapped areas of this soil.

This phase of Marshall fine sandy loam occurs in numerous small bodies within and around the northern edge of the loessial uplands and in many small valleys and pockets within areas of sandy soils. Practically all of it is in the southern half of the county.

The soil is well drained. There are few surface drainageways, but the porous subsoil affords ample underdrainage. Nearly all the land is under cultivation. Corn and oats are the principal crops. Alfalfa, potatoes, and rye are grown to a small extent. Crop yields average between 5 and 10 percent lower than those obtained on Holdrege silt loam.

Hall silt loam.—Hall silt loam is the most extensive soil on the terrace lands in Garfield County. The greater part of it is in the valley of North Loup River. This soil has developed from silty to only slightly sandy alluvial sediments which were deposited on the flood plains when the streams were flowing at higher levels. Later stream entrenchment has left the deposits on terraces or benches from 6 to 25 feet above the present channels.

The land is nearly level or very gently undulating but has sufficient slope down the valleys and toward the streams to afford ample surface drainage. It has good underdrainage.

The topsoil consists of very dark friable silt loam from 12 to 14 inches thick. The upper part of the subsoil is a trifle lighter in color and slightly heavier than the overlying horizon but is crumbly and friable. Downward it gives way gradually to light grayish-brown loose floury silt or very fine sandy loam, which contains an abundance of lime. Unaltered or only slightly modified silty stream sediments are within a depth of 4 feet, in most places.

Hall silt loam is one of the most productive soils in the county. It is naturally strong and fertile and if given average care is able to withstand severe cropping with little reduction in yields. Nearly all of it is under cultivation. Corn, oats, alfalfa, and wheat are the leading crops, ranking in acreage in about the order named. During average seasons corn and oats yield about 30 bushels and wheat and rye about 15 bushels an acre. The acre yield of alfalfa is about 2½ tons. The latter crop occupies a larger percentage of Hall silt loam than it does of any other soil on the terraces.

Hall very fine sandy loam.—Hall very fine sandy loam has developed on fine-textured terrace deposits and is closely associated with Hall silt loam, from which it differs only in texture of the

topsoil. Most of it is in the valleys of North Loup and Calamus Rivers and Bean and Haskell Creeks.

The topsoil is mellow dark-colored very fine sandy loam from 12 to 14 inches thick. It contains a considerably higher percentage of very fine sand than is present in the corresponding layer of Hall silt loam, but it remains coherent and is not subject to destructive wind erosion. The subsoil is almost identical with that of the silt loam. It is dark grayish brown in the upper part, where stained by organic solutions from above, and is light colored and limy in the lower part.

Areas of this soil are nearly level or very gently undulating. Drainage is thorough. Even the more nearly level areas have sufficient gradient to carry off the surplus surface moisture, and the subsoil affords ample underdrainage.

This soil is as strong and productive as Hall silt loam, but it is of minor agricultural importance on account of its small extent. Practically all of it is under cultivation.

Waukesha silt loam.—Waukesha silt loam resembles Hall silt loam in general appearance and where typically developed differs from that soil only in that it is more thoroughly leached of its lime. In this county, all the Waukesha soils have more sandy subsoils than are typical for soils of this series. These soils, in addition to being less limy, are much more sandy than the Hall soils.

The topsoil of Waukesha silt loam consists of very dark silt loam from 12 to 15 inches thick. It is friable and contains a high percentage of organic matter. The upper part of the subsoil, which extends to an average depth of 24 inches, is slightly lighter colored and heavier than the topsoil. It consists of silt loam or silty clay loam. It merges downward into grayish-brown very fine sandy loam which gives way to gray fine sand, generally within a depth of 40 inches.

Waukesha silt loam is on nearly level or gently undulating terraces from 10 to 25 feet above the stream channels, and it is well drained. The slope is sufficient, even in the flatter areas, to carry off the surplus water. This soil occurs chiefly in the North Loup River Valley southeast of Burwell.

This soil has developed from old alluvial sediments which were deposited prior to the present bottom lands. Surface wash from the adjoining uplands has contributed to the sediments, especially near the foot of the steeper slopes.

Nearly all of the land is under cultivation. Corn occupies the largest acreage, followed in order by oats, alfalfa, and wheat. Crop yields are about the same as those obtained on Hall silt loam. In fact, all the Hall and Waukesha soils are regarded with equal favor by the farmers for general farming.

Waukesha very fine sandy loam, sandy-substratum phase.—This phase of Waukesha very fine sandy loam is chiefly on the terraces along North Loup River where it occupies several bodies, the largest of which comprises about 1,000 acres in the vicinity of Burwell.

This soil has developed in the same manner as has Waukesha silt loam but from slightly sandier terrace deposits. It differs from that soil chiefly in having a little more sand in its topsoil.

The land is nearly level or gently undulating, and drainage is everywhere good. As this soil lies from 8 to 20 feet above the first bottoms, it is not subject to overflow from the main streams.

The topsoil consists of very dark grayish-brown mellow and coherent very fine sandy loam from 10 to 15 inches thick. The upper part of the subsoil, which extends to an average depth of 24 inches, is slightly lighter colored than the overlying layer but does not differ materially from it in texture. The rest of the soil profile consists of loose gray sand.

The soil is low but not deficient in lime. Although rather sandy it is neither droughty nor unstable, and practically all of it is under cultivation. The same crops are grown and about the same yields are obtained as on Hall silt loam.

SOILS BEST SUITED TO CORN, RYE, AND SWEETCLOVER

The soils of this group include the Thurman, Anselmo, O'Neill, and Sparta, all of which are composed largely of sand. The first two named are on the uplands, where they occupy numerous small areas scattered throughout the sand hills and around the northern edge of the loess-mantled uplands. The O'Neill and Sparta soils are on sandy stream terraces, chiefly along North Loup, Calamus, and Cedar Rivers.

The Thurman and O'Neill soils have accumulated rather large quantities of organic matter and have dark topsoils. In addition, the topsoils contain small quantities of silt which, together with the organic matter, makes them fairly stable, provided reasonable care is taken to retard drifting. The Anselmo and Sparta soils are low in organic matter and light colored from the surface downward. The Anselmo soils contain more silt than any other soil in this group. They are about as stable as the Thurman soils.

These soils range from nearly level to rolling. Drainage channels are not well established as nearly all of the surplus moisture passes downward. The subsoils are composed of incoherent sand which has allowed deep soil leaching. Lime has been removed from all soils of the group except the Anselmo, in which it still occurs in places.

The greater part of each of these soils is farmed. The silt and organic matter in the topsoils of most of them allow the retention of considerable moisture in the upper part of the soil profile. The moisture in the sand subsoils, however, is not sufficiently concentrated and lies a little too deep, in average years, for the highest yields of farm crops. When dry seasons are accompanied by windy weather, oats and wheat return very low yields because the drifting sands expose the root systems to drought. Therefore, these crops are seldom grown. Alfalfa does fairly well, provided a good stand is obtained, but this crop is so easily injured by drought and drifting sand during the seedling stage that the risk involved in obtaining a satisfactory stand on sandy land is almost prohibitive, except on some of the O'Neill soils.

Corn, which is planted deep and which has large anchor roots and a rather widespreading root system, is not greatly injured by drifting sand. It produces fair yields on the sandy soils even during the drier years and, because it is the principal feed crop, it is grown more extensively than small grains.

The continued production of corn rapidly depletes the nitrogen in the soil, and in order to remedy this condition, more sweetclover is grown on the soils of this group than on those of any other group. Sweetclover, although not valued so highly for feed as alfalfa, is much better adapted to sandy soils than that crop. Less difficulty is experienced in obtaining a good stand of sweetclover than of alfalfa, and the crop requires less moisture, can be sown earlier in the spring, and is much hardier. In addition, it is as well equipped to obtain nitrogen from the air and store it in the soil. Without sweetclover the farmers on the sandy soils would experience much difficulty in maintaining favorable yields of corn.

Rye is better adapted to sandy soils than any other grain crop commonly grown, except corn, and, as it is valuable for hog feed and late fall pasture, it is grown rather extensively on these soils. This crop is generally planted in the fall. It makes a luxuriant fall growth which protects the soil from drifting.

Although the Thurman, Anselmo, O'Neill, and Sparta soils are not suited to so wide a variety of crops as are the finer textured soils and are less productive, they comprise the only land which can be satisfactorily farmed in the sand-hill section of the county.

Thurman loamy fine sand.—Thurman loamy fine sand is one of the more extensive soils belonging to this group. It occurs throughout the uplands wherever almost pure fine sand or medium sand has acquired a very dark surface layer through the prolonged accumulation of organic matter. It is in scattered bodies of various shapes and generally small sizes chiefly in the southern half of the county, and some small areas are in the northern part. The largest developments, few of which cover more than 400 acres, are in Midvale Precinct.

The land ranges from almost level to gently rolling. Drainage channels are not well developed because nearly all of the precipitation is rapidly absorbed by the porous sand.

The topsoil, which ranges from 8 to 14 inches in thickness, is dark grayish-brown or very dark grayish-brown loamy fine sand. The upper part of the subsoil is pale brown and about 10 inches thick. It consists largely of fine sand but contains enough silt to weakly bind the sand grains together and to give the material slight coherence, or "body." The rest of the soil profile is incoherent gray sand similar to that beneath the Valentine soils and dune sand. Neither the surface soil nor subsoil is limy.

Thurman loamy fine sand does not contain sufficient fine material to hold the soil against drifting when the native grass cover is destroyed, and for this reason it is not so well suited for crops, especially small grains, as is heavier land. Most of it is in areas where the surrounding soils are so extremely low in organic matter and so unstable that they are suited only for pasture and the production of wild hay. As some land in these areas is needed to produce grain feed, Thurman loamy fine sand is usually chosen, and nearly all of it is under cultivation.

Corn, as on all the arable land in the county, occupies the largest acreage on this soil. A small amount of rye and sweetclover are grown but practically no oats or wheat. Crop yields are lower than on the finer textured soils of the group. The average yield of corn

over a period of years is about 10 bushels an acre and that of rye about 12 bushels. Sweetclover when cut for hay yields about 0.7 ton an acre. Most of this crop and much of the rye is used for pasture.

Thurman fine sandy loam.—This soil differs from Thurman loamy fine sand only in that it has a higher silt content in its topsoil layer which is considerably more coherent and stable than the corresponding layer of the loamy fine sand. The soil occurs in numerous though generally small areas on slopes and gently rolling land, chiefly in Willow Springs and Midvale Precincts.

The topsoil consists of dark grayish-brown or very dark grayish-brown friable fine sandy loam from 10 to 16 inches thick. It contains an abundance of organic matter which accounts for its dark color and which, together with the silt, tends to stabilize the sand. The rest of the soil mass is composed of incoherent fine sand or medium fine sand, which is grayish brown in the upper part, where stained by organic solutions from above, and light grayish brown in the lower part.

Here and there, in intensively cultivated and poorly managed fields, the wind has removed much of the organic matter and silt from the topsoil, but in most places the soil has not been greatly injured by wind erosion. No part of the soil material contains sufficient lime to effervesce when hydrochloric acid is applied.

Drainage channels are not well established, but the soil absorbs water rapidly and has adequate underdrainage. Nearly all of the land is under cultivation. The same crops that are grown on Thurman loamy fine sand are grown with about a 10-percent increase in yields on Thurman fine sandy loam. Corn is the leading crop.

Anselmo loamy fine sand.—Anselmo loamy fine sand occupies numerous small areas ranging in size from less than 5 to about 60 acres. Most of them are in Rockford and Willow Springs Precincts.

This soil differs from Valentine loamy sand chiefly in having a larger silt content, a slightly darker topsoil, and a more coherent lower subsoil layer. The topsoil, which averages about 4 inches thick, is grayish brown or dark grayish brown and consists largely of fine sand. It contains sufficient silt and organic matter to give it a loamy texture, but not enough to prevent soil drifting in cultivated fields during prolonged periods of dry windy weather. The upper part of the subsoil is composed of loose gray sand which extends to an average depth of 20 inches. The lower subsoil layer, to a depth of about 3 feet, consists of light grayish-brown loamy fine sand. It contains more silt and clay and is much more coherent than any part of the subsoil in the Thurman and Valentine soils. In most places this layer is underlain by incoherent gray fine sand. This soil is not calcareous at any depth.

The relief ranges from nearly level to slightly rolling. Surface drainage is not established, but the porous topsoil and subsoil afford ample underdrainage.

Practically all of the soil is farmed, chiefly to corn. Some rye, sweetclover, alfalfa, and potatoes are grown. The average yield of corn is about 10 bushels an acre and of rye about 16 bushels.

Anselmo fine sandy loam.—Anselmo fine sandy loam occupies a few small bodies in the southwestern quarter of the county where it

is in close association with both loess- and sand-derived soils. It is transitional in character and position between the two.

The topsoil is grayish-brown or dark grayish-brown loosely coherent fine sandy loam ranging from 7 to 10 inches in thickness. It contains only a small amount of organic matter. The upper part of the subsoil is light grayish-brown moderately coherent fine sandy loam which extends to an average depth of 14 inches. It contains sufficient silt to loosely bind the sand grains. The rest of the soil mass consists of very light grayish-brown friable fine sandy loam containing more silt and clay than the material in any other horizon. It rests, at an average depth of 3 feet, on incoherent gray sand. The soil is not noticeably limy except in a few localities.

The relief ranges from almost level to gently rolling. Drainage channels are not well developed, but the soil is sufficiently porous to rapidly absorb the surplus surface moisture, and all the land is well drained.

This soil is not important agriculturally on account of its small extent. It is more stable, has much higher moisture-retaining power, and is more productive than any Valentine soil. Practically all of it is under cultivation. Corn, rye, and sweetclover are the chief crops, and some alfalfa and oats are grown. Crop yields on Anselmo fine sandy loam are about the same as on the corresponding type of the Thurman soils.

O'Neill loamy fine sand.—This soil occupies scattered areas on sandy stream terraces, chiefly in the valleys of Cedar and Calamus Rivers and Dry Cedar Creek. The largest development is on the east side of Cedar River in Erina Precinct.

The topsoil is very dark grayish-brown fine sandy loam from 10 to 15 inches thick. It consists mainly of fine sand but contains sufficient organic matter to give it a loamy texture. The subsoil is composed of slightly coarser sand than the topsoil. It is low in organic matter and becomes gradually lighter in color with depth, being very light grayish brown in the lower part. Scattered pebbles are on the surface and throughout the soil profile. They generally increase in abundance with depth but do not markedly influence the general texture of any layer. None of this soil contains sufficient lime to react noticeably when hydrochloric acid is applied.

In general, areas of O'Neill loamy fine sand are nearly level or slightly undulating. At some places, where the wind has been especially effective in drifting the soil, the relief is hummocky. Surface drainage channels are poorly developed because the sandy surface soil and subsoil absorb all surplus moisture as rapidly as it accumulates.

About 90 percent of this soil is under cultivation, and the remainder is used for pasture and hay land. Corn, rye, and sweetclover are the leading crops. Yields are lower than those on the Waukesha and Hall soils but slightly exceed those on Thurman loamy fine sand of the uplands.

O'Neill fine sandy loam.—O'Neill fine sandy loam differs from O'Neill loamy fine sand only in having a finer textured topsoil. It occurs in small irregular-shaped areas on the more sandy parts of the terraces along North Loup, Calamus, and Cedar Rivers. The largest area, comprising about 300 acres, is a short distance south of Burwell.

In common with all O'Neill soils, this soil is composed mainly of sand. The topsoil is loose fine sandy loam from 10 to 15 inches thick. It contains an abundance of well-decayed organic matter and is very dark grayish brown. The silt content also is rather high, and the material is fairly stable against wind erosion. The subsoil, which consists of fine sand or medium loose sand, is grayish brown in the upper part and light grayish brown or gray in the lower. The material in this layer is very low in lime.

The relief is nearly level or very gently undulating, and all the land is well drained. The terraces on which this soil is developed are from 6 to 8 feet above the present stream channels and are not subject to overflow.

Nearly all of this soil is under cultivation, and corn, rye, and sweetclover are the leading crops. Some oats are grown. Crop yields average about one-third lower than those obtained on the Waukesha soils.

Sparta sand.—Sparta sand occurs in several small bodies and discontinuous strips on sandy terraces within the larger stream valleys. It is most extensive along Cedar River and Dry Cedar Creek.

This soil has a much lighter colored topsoil than any O'Neill soil on the sandy terraces, as it has accumulated very little organic matter. The 6- to 9-inch surface soil consists of grayish-brown fine sand or medium sand which contains sufficient organic material to give it a slightly darker color than the rest of the soil mass but not enough to prevent the sand from drifting where not protected. The subsoil is incoherent gray sand containing slight traces of organic matter in the upper part but practically none below a depth of 20 inches. Neither the surface soil nor subsoil is limy.

The areas of Sparta sand are nearly level except in places where the wind has produced slight depressions and low rounded ridges and hummocks. Even in such localities, differences in elevation generally do not exceed 2 feet. Drainage is everywhere good.

This soil is not well suited to grain and tame-hay crops, owing to its extremely sandy and unstable character, but the demand for feed has caused farmers to bring about 10 percent of it under cultivation.

Corn occupies about 80 percent of the cultivated land, but yields are generally low. Most of the remaining farmed acreage, not in rye, is used for sweetclover. The average yield of corn is about 20 bushels an acre. Practically all of the rye and sweetclover are grown for pasture.

SOILS BEST SUITED TO CORN AND ALFALFA

The soils of this group include the Lamoure and Cass soils of the first bottoms or flood plains along the larger streams. These soils are very strong and productive soils for corn and alfalfa, and about 85 percent of the area occupied by them is devoted mainly to these crops. The remainder, including patches too small for profitable farming, too poorly drained for cultivation, or covered by forest growth, is used for native pasture and hay land.

The relief of areas occupied by the soils of this group is nearly level with an almost imperceptible slope down the valleys and toward the stream channels. Surface drainage, although rather slow, is well

established except in a few places. Nearly all of the land is subject to overflow during high stages of the streams, but as most of it lies from 3 to 5 feet above the channels, the water drains off within a few hours after the streams subside. The only poorly drained bodies are in small depressions. The water table in the larger valleys is from 4 to 15 feet beneath the surface of the ground, and the lower part of the subsoil is kept well supplied with moisture even during the drier years.

The materials from which the soils of this group have developed consist of recently deposited stream sediments, none of which has been greatly altered since deposition. Therefore the character of the sediments is the dominant factor in determining the character of the soils. The Lamoure soils have developed from the finer stream deposits, chiefly silt and clay, and the Cass soils have formed from sand and gravel. These soils are naturally better supplied with moisture than the soils on the uplands and terraces, because the precipitation received by them is supplemented by seepage and run-off from higher levels and by the underlying water table. The run-off carries considerable organic matter and other plant nutrients to the lower levels. In addition the moist conditions prevailing in the bottom lands have favored the rapid growth and decay of vegetation, and the soils of the group as a whole are better supplied with organic matter and have darker topsoils than those belonging to the other soil groups.

The high content of organic matter and the abundant moisture supply make these soils especially suited for corn. The moisture is also very favorable for alfalfa in areas where the ground-water table is not too near the surface of the ground. In such areas alfalfa can be grown as continuously as desired without decreasing the subsoil moisture to the point where yields decline, as they do when the higher lying soils are continually used for this crop. Alfalfa, however, does not do well in areas where the water table is at any time less than 4 feet beneath the surface.

Small-grain crops grow well on the soils of this group, but they have a tendency to produce a rank growth of vegetation at the expense of the grain. As these crops generally mature late, yields are rather low. They are not grown on the bottom lands except in a few places.

Cass loamy fine sand.—Cass loamy fine sand is by far the most extensive soil of this group. It is on the bottom lands of North Loup, Calamus, and Cedar Rivers, and along all the creeks throughout the sandy uplands.

The relief, in most places, is nearly level or very gently undulating. Here and there it is somewhat hummocky, but the local relief does not exceed 2 feet except along old and active stream channels. The water table is nearly everywhere within a depth of 6 feet. On more than one-half of the area of this soil, it rises to a level within less than 4 feet of the surface of the ground in the spring and following prolonged periods of rainy weather. Temporary marshes are produced in the lower situations during some years.

The topsoil, which averages about 10 inches thick, is loose dark grayish-brown or very dark grayish-brown loamy fine sand. It contains a large quantity of well-decomposed organic matter which ac-

counts for its dark color and loamy texture, but which is not sufficient to prevent the sand from drifting during prolonged dry windy spells if the soil is not protected by vegetation. The subsoil is light grayish-brown loamy fine sand which grades at a depth of about 20 inches into incoherent gray sand containing numerous rusty-brown spots, splotches, and streaks. It is very low in organic matter. The soil may be slightly limy from the surface downward.

About 55 percent of the area occupied by Cass loamy fine sand is under cultivation, and the remainder is used for pasture and hay land. Corn and alfalfa, grown in the ratio of about 15 acres of the former to 1 of the latter, are the leading cultivated crops. Some oats are grown, but this crop occupies only an occasional field. The native vegetation includes big bluestem and needlegrass, where drainage is adequate, and canary grass and sloughgrass in the lower places.

The average acre-yield of corn or oats is about 20 bushels and that of alfalfa about 2 tons of hay. Native hay on poorly drained areas yields about four-fifths of a ton an acre. The pasturage on similar areas of this soil will support a cow or steer on each 4½ acres during the summer grazing season, May to October, inclusive.

Cass fine sandy loam.—This soil occurs in a few small areas on the sandy bottom lands, chiefly along North Loup, Calamus, Cedar, and Little Cedar Rivers. Most of the bodies adjoin areas of Cass loamy fine sand, and the two soils are almost identical except in texture of the topsoil. The surface layer of Cass fine sandy loam contains a little less sand and more silt and is consequently a little more stable than the corresponding layer of Cass loamy fine sand.

The 8- to 12-inch topsoil is very dark grayish-brown friable fine sandy loam, and the underlying soil material consists of incoherent sand which is grayish brown in the upper part and light grayish brown with numerous rust-colored stains and streaks in the lower part. The soil may or may not be slightly limy.

The land lies from 4 to 7 feet above the normal water level of the streams, but it is seldom inundated. Drainage in most areas is sufficient for profitable farming during most years. In very wet seasons, however, the water table rises to a position too near the surface, over about one-half of the land, for most farm crops.

About 70 percent of Cass fine sandy loam is used for growing corn and alfalfa, and most of the remainder is in native pasture and hay land. Some clover and timothy are grown. Crop yields are between 5 and 10 percent higher than on Cass loamy fine sand.

The native vegetation on this soil includes a variety of water-loving grasses interspersed here and there with volunteer timothy and clover.

Cass very fine sandy loam.—Cass very fine sandy loam has less sand in its topsoil than any other Cass soil in Garfield County. Otherwise, it is similar to the other Cass soils. It occupies several small bodies on the bottom lands where it is closely associated with areas of Cass loamy fine sand and Cass fine sandy loam. Most of it is along North Loup River and tributaries of Cedar River. It has a small total area.

The 8- to 14-inch topsoil consists of very dark grayish-brown very fine sandy loam mixed with an abundance of organic matter. The

subsoil is dark grayish-brown or gray sand, the gray becoming more pronounced with depth. The soil material in this layer contains little organic matter and is incoherent throughout. The lower part is stained with rusty-brown streaks, splotches, and spots.

The relief is nearly level, and the land lies only 3 or 4 feet above the stream channels. It is subject to frequent inundation, and the soil, as a whole, is rather poorly drained, especially in the lower part. During most years, however, there is sufficient drainage for the production of corn, and in many places alfalfa can be grown.

About 60 percent of this soil is under cultivation. The remainder supports a luxuriant growth of prairie grasses or is covered by forest and is used for pasture and hay land.

Throughout the better drained areas, corn yields from 25 to 30 bushels an acre and alfalfa about 2½ tons of hay. A small amount of mixed timothy and clover is grown for hay in localities where the water table is a little too high for the production of alfalfa but where the ground is not too wet to cultivate. This mixture usually yields about 1 ton of excellent hay an acre. Most of the timothy and clover hay is fed to the work animals. The native grasses on the poorly drained areas produce from ¾ to 1 ton of hay an acre.

Lamoure silt loam.—Lamoure silt loam occupies a few small bodies on the finer textured parts of the bottom lands along North Loup River. It has developed from silty, clayey, or only moderately sandy stream deposits and is much finer textured than any Cass soil. It lies only a few feet above the river channel and is subject to occasional overflow. Most bodies of this soil, however, are sufficiently well drained for the production of corn and alfalfa. They lie a little above one or another of the surrounding soil areas, to which the water drains when the streams subside. Poorly drained land occurs chiefly in small scattered pockets where the water accumulates. It also occurs in abandoned stream channels, the beds of which are at or near the top of the water table.

The topsoil, which ranges from 6 to 10 inches in thickness, consists of very dark grayish-brown friable silt loam containing an abundance of well-decomposed grass remains. The upper part of the subsoil is dark grayish-brown friable very fine sandy loam which extends to an average depth of 18 inches. The remainder of the soil profile is light grayish-brown fine sandy loam containing numerous rusty-brown stains and streaks. The topsoil in most places is limy, and the subsoil contains more lime than is present in the corresponding layer of any other soil in the county.

Included with this soil on the accompanying map is a small area of Lamoure very fine sandy loam, on the bottom lands east of North Loup River where that stream crosses the southern county line. The soil of the included area differs from Lamoure silt loam only in that it has a slightly more sandy topsoil.

Lamoure silt loam where adequately drained is one of the strongest and most productive soils for corn and alfalfa in the county, and most of it is used for these crops. Corn averages about 28 bushels an acre and alfalfa hay about 2½ tons. The more poorly drained land is used for pasture and the production of wild hay. It supports a luxuriant growth of moisture-loving grasses which yield slightly more than a ton of hay an acre during most years.

SOILS BEST SUITED TO NATIVE PASTURE AND HAY GRASSES

One or another of the soils classed with this group occurs in all parts of the county wherever the land, because of unfavorable relief, poor drainage, or lack of stability, is unsuited to cultivation. The group includes the Valentine, Colby, Gannett, and Sarpy soils in addition to areas of dune sand and rough broken land.

Nearly all of these soils, as well as dune sand and rough broken land, include some fields that are under cultivation, but the greater part of each remains in its virgin condition. About 90 percent of the area occupied by the group as a whole is used for native pasture or hay land.

All soils in the group occupy upland positions, except Sarpy sand on the bottom lands and Gannett loamy sand in pockets and swales throughout the sand hills. These soils and land types have a wide range in relief and soil characteristics. The Valentine, Sarpy, and Gannett soils and dune sand are composed largely or almost entirely of sand. Of these Gannett loamy sand is the only one that has accumulated much organic matter. It is very poorly drained. The Colby soils and rough broken land have developed from loessial deposits and are composed largely of silt. They are too steeply sloping and severely eroded to have accumulated much organic matter and are rather light colored, even at the surface.

Dune sand.—Dune sand includes hilly areas of wind-blown sand, commonly known as sand hills. One of the largest and most uniform developments covers about 50 square miles in parts of Dry Cedar, Roosevelt, Bryan, and Erina Precincts.

This material is not a true soil, but it supports a fair grass cover and is valuable for grazing land. It consists of gray incoherent sand of the fine or medium grades to a depth exceeding 10 feet. The sand was derived largely through the disintegration of soft Tertiary sandstones but came partly from water-deposited beds of later age. The general absence of silt and clay is probably due to the removal of these materials by the wind. The sand does not contain lime.

Dune sand differs from Valentine sand chiefly in that it has less even relief. In most places the sand has been whipped by the wind into irregularly distributed hills and ridges, ranging from 20 to 80 feet in height. Old and recent blow-outs are on many of the hills, generally on the northwest sides. Pockets, valleys, and swales, some of which are occupied either by Valentine or Gannett soils, are between the hills and ridges.

The dune sand areas are of no value for cultivation. Isolated patches have been farmed but the material is so subject to blowing that the removal of the grass cover ruins the land. Practically all of the dune sand remains in its virgin state and is used for grazing land. The native vegetation includes many valuable pasture, hay, and sand-binding grasses, of which little bluestem, blow-out grass, sand reedgrass, *Redfieldia*, and needlegrass are the most common. During the spring and summer these grasses will support from 70 to 80 head of cattle on each square mile. They cannot be depended on for winter grazing. When cut for hay they yield about one-third of a ton an acre.

Valentine fine sand.—Valentine fine sand lies adjacent to areas of dune sand, from which it differs in that it is less hilly, has a heavier grass cover, and contains a trifle more organic matter in its surface layer. The largest areas of this soil are in Dry Cedar, Highland, and Erina Precincts.

The 5- to 8-inch topsoil consists of grayish-brown incoherent and unstable sand. The upper half generally is somewhat darker than the lower, owing to a small content of organic matter. The remainder of the soil profile, to a depth exceeding 5 feet, is texturally similar to the topsoil but it is lighter colored. The soil has been thoroughly leached of its lime throughout.

The color and depth of the topsoil varies somewhat with the topographic position. In shallow depressions, where conditions have been most favorable for the growth and decay of vegetation, this layer is somewhat darker and deeper than typical. On knolls and ridges most of the organic matter has been removed by wind, leaving the topsoil very shallow and light colored.

The relief ranges from almost flat to rolling. Most of the more level areas are modified by scattered low rounded knolls and ridges. Surface drainage channels are not established, but underdrainage is everywhere good.

Valentine fine sand is of little value for crop production on account of its unstable nature and low organic-matter content. Only scattered fields, which are used chiefly for growing corn and sweetclover, are under cultivation. Most of the land remains with its native covering of grasses and is used for cattle grazing land and the production of wild hay. The native vegetation, which consists chiefly of sandgrass, needlegrass, and little bluestem, will support from 80 to 90 head of cattle on each section, or when cut for hay will yield from one-third to one-half ton an acre.

Valentine loamy sand.—This soil is in numerous but generally small areas throughout the sandy uplands of the county. Most of it is within larger areas of Valentine fine sand, where it occupies the lower and more level land. It supports a slightly heavier grass cover than Valentine fine sand, is a little better supplied with organic matter, and has a trifle thicker and more stable topsoil. The entire soil, however, is composed mainly of incoherent sand or fine sand, and when the grass cover is destroyed the organic matter is rapidly removed from the topsoil by the wind unless extreme care is exercised in managing the land.

Surface drainage is not established, because all moisture sinks rapidly into the porous sand, and there is practically no run-off.

Owing to its lower position, greater stability, and higher content of humus, Valentine loamy sand is used more for crops than is Valentine fine sand. About 20 percent of the loamy sand is under cultivation, mainly to corn, rye, and sweetclover. Yields are low except in the most favorable seasons. Much of this soil, in farmed fields, has become so unstable that it is practically worthless either for crops or for hay and pasture land. The ultimate use of such fields depends on the reestablishment of the prairie grasses.

The native grasses on virgin areas of Valentine loamy sand will support a cow or steer on each 4 or 5 acres during the summer grazing

season, or when cut for hay will yield about a ton from 3 or 4 acres. The hay-producing and livestock-carrying capacities of the grasses differ from year to year, according to differences in the amount of the precipitation.

Gannett loamy sand.—Gannett loamy sand occupies a few small wet depressions within areas of dune sand and the Valentine soils. Few of the depressions exceed 20 acres, and most of them are much smaller.

The Gannett soil has no surface drainage outlets, and the areas in which it occurs are locally known as wet hay meadows. These areas receive considerable seepage water from the higher lying sandy soils, and during the spring they remain waterlogged for long periods. In places the water covers the surface of the ground, thereby producing temporary marshes and lakes.

The topsoil is very dark, in places almost black, loose loamy sand or loamy fine sand from 8 to 14 inches thick. In a few places it contains so much organic matter in various stages of decay that it has a rather spongy structure and is appreciably light in weight. The subsoil consists largely of incoherent gray sand containing numerous rust-brown splotches, spots, and streaks. It includes a horizontal layer, ranging from 2 to 10 inches in thickness, of pale grayish-blue or grayish-green sticky sandy clay which lies, in most places, between depths of 2 and 4 feet. This layer, known as the glei layer, has developed at or near the top of the water table.

Gannett loamy sand supports a luxuriant growth of water-loving grasses with rushes and sedges in the wetter situations. In most places it is a little too wet for pasture land and is used largely for the production of hay. The hay is rather coarse and does not have as high feeding value as that from better drained land, but the average acre-yield is about a ton, which is more than is obtained from any of the higher lying soils.

Sarpy sand.—Sarpy sand occupies a few small bodies and narrow broken strips on the bottom lands along North Loup, Calamus, and Cedar Rivers. It lies from 2 to 5 feet above the normal level of the streams and is subject to occasional inundation.

This soil has formed on recently deposited sandy alluvium. It is not old enough to have developed a dark-colored topsoil through the growth and decay of vegetation. The soil mass consists mainly of light grayish-brown incoherent sand from the surface downward. The topsoil, to a depth of 2 or 3 inches, may contain enough organic matter to make it slightly darker than the rest of the material, and the sand, in places, may be mixed more or less with gravel.

Areas of this soil are nearly level or very gently undulating. The water table lies at a slight depth and in wet years rises to the surface of the ground in the lower situations.

Owing to its small extent, incoherent sandy character, and uncertain drainage, Sarpy sand is little used for cultivated crops. Most of it is covered by a scrubby forest growth and is included in pasture land.

Colby silt loam.—Colby silt loam is the most extensive "hardland" soil used for native pasture land and the production of wild hay. It occurs on the loessial uplands where it is in close association with the Holdrege soils, but the Colby soil occupies the steeper valley

slopes and sharper ridge crests. The largest developments are in Rockford, Midvale, and Dry Cedar Precincts.

This soil has been subjected to considerable erosion during its development, but the land is not so steeply sloping and the surface features are not so angular as in areas of rough broken land. It resembles Holdrege silt loam except for its less even relief and thinner and lighter colored surface layer.

The friable silt loam topsoil has accumulated sufficient organic matter, in most places, to give it a dark grayish-brown color to an average depth of 6 inches. The remainder of the soil mass is light grayish-brown or grayish-yellow silt with a high lime content. This profile is typical in all localities where the soil is best developed, but, as mapped in this county, Colby silt loam is variable. In some areas the topsoil is only about 2 inches thick and rests directly on the unweathered or only slightly modified loess from which the soil has developed. In others, the topsoil has not developed or has been entirely removed, and the parent loess is exposed. All areas of the soil include numerous patches in which the latter condition prevails.

This soil is suited for crop production, but most of it is so steeply sloping and erodes so badly when the native sod is broken that only a small part is under cultivation. All crops commonly grown in the county are produced in situations where the relief is favorable, but corn and sweetclover occupy most of the cultivated land. Yields average about one-half lower than those obtained on the Holdrege soils. During periods of high precipitation, much of the corn and small grain wash out and must be replanted if a good stand is to be obtained.

The greater part of the soil is used for grazing and hay land. The native vegetation consists of a good growth of grama, little bluestem, big bluestem, and other grasses, which, in average years, will support about 100 cattle on each square mile or, when cut for hay, will yield nearly one-half ton an acre.

Colby very fine sandy loam.—This soil resembles Colby silt loam in all features except the texture of the topsoil. It occupies only a few small areas, most of which are around the northern edge of the loessial uplands where wind-blown sand from the neighboring sandy soils has slightly coarsened the surface layers of the more silty areas.

The topsoil, which does not exceed 6 inches in thickness, is grayish-brown very fine sandy loam or loamy fine sand, but, owing to the preponderance of the former texture and to the small extent of the sandy Colby soil in this county, all this soil is included with the very fine sandy loam on the soil map. The subsoil consists of loose floury and limy silt similar to that underlying Colby silt loam.

Most areas of this soil are too steeply sloping for cultivation. Some corn, sweetclover, and alfalfa are grown on the more gradual slopes, but the greater part of the soil is included in native pasture and hay land.

Colby very fine sandy loam has about the same value for crops as Colby silt loam, but, owing to its small extent, it is of minor agricultural importance.

Rough broken land (Colby soil material).—Small areas of rough broken land are scattered throughout nearly all parts of the loes-

sial uplands. The largest developments are in Rockford, Willow Springs, and Dry Cedar Precincts.

This land is simply one or another of the Colby soils on which a topsoil has not developed or has been almost or entirely removed by erosion, and on which the relief is extremely rugged and broken. Steep slopes abound. The land has been severely dissected by intermittent streams which have cut deep and, in places, almost vertical walled valleys. The divides are very narrow. Run-off is everywhere excessive. Rough broken land is used almost exclusively for pasture land, although some hay is cut on the less steeply sloping areas. This land has a slightly lower grazing value than has Colby silt loam.

CLASSIFICATION OF SOILS ACCORDING TO PRODUCTIVITY

In table 6 the soils are classified according to their estimated ability to produce the more important crops commonly grown in this section.

This classification compares the inherent productivity of each of the soils for each of the leading crops in the county to a standard, namely 100, which is the rating given to a soil that is inherently the most productive in the United States for the crop under consideration and which occupies sufficient acreage to warrant classing it as the standard soil for that crop. The rating 100 is called the base index and is the standard with which the productivity of all other soils for a particular crop is compared. Thus, a soil estimated to be half as productive of a given crop as the one having the base index rating receives an index of 50. A few unusually productive soils of small total acreage may have an index above 100 for a specified crop.

Inherent-productivity indexes show the natural ability of the soil to maintain production at or near the level existing when the soil has become adjusted to tillage. These indexes are established under the assumption that the best cropping and soil-management practices are followed, excepting those that would materially modify the soil, such as the use of commercial fertilizer, residues and manures from crops not grown on the soil, terraces, irrigation, and artificial drainage.

In this table the soils are listed in the order of their general productivity, which is determined chiefly by their ability to produce the more important staple crops. No attempt is made to group the soils best suited for particular crops, and no consideration is given to differences in the quality of the crops.

As the soils in Garfield County do not receive lime or commercial fertilizers, no rating is given to indicate their response to these materials.

The factors influencing the productivity of the soils are mainly climate, soil characteristics, and relief, or lay of the land. Since long-time yields[4] furnish the best available summation of the factors

[4] Data on long-time yields for specific soils were collected by the field parties during and subsequent to the soil survey. Also free use was made of unpublished estimates on average annual crop yields for the period 1923–32 supplied by the Bureau of Agricultural Economics, U. S. Department of Agriculture, and the Nebraska Department of Agriculture, cooperating.

contributing to soil productivity, they were among the data used in determining the inherent productivity indexes given in this table.

TABLE 6.—*Classification of soil types in Garfield County, Nebr., according to productivity* [1]

Soil type [2]	Crop productivity index [3] for—									Principal crops or type of farming
	Corn	Oats	Wheat	Rye	Barley	Alfalfa	Sweet-clover	Wild hay	Pasture	
Hall silt loam	60	60	60	60	55	55	65	70	35	General farming.
Waukesha silt loam	60	60	60	60	55	55	65	70	35	Do.
Hall very fine sandy loam	60	60	60	60	55	55	65	70	35	Do.
Waukesha very fine sandy loam, sandy-substratum phase.	60	60	60	60	55	55	65	70	35	Do.
Lamoure silt loam (well drained)	55	50	50	50	45	55	75	85	43	Corn and alfalfa.
Cass very fine sandy loam (well drained)	55	45	45	50	40	55	75	85	41	Do.
Cass fine sandy loam (well drained)	50	35	35	45	35	50	75	80	40	Do.
Holdrege silt loam	50	50	50	50	45	30	65	70	35	General farming.
Holdrege very fine sandy loam	50	50	50	50	45	30	65	70	35	Do.
Marshall very fine sandy loam, sandy-substratum phase.	50	50	50	50	45	30	65	70	35	Do.
Marshall fine sandy loam, sandy-substratum phase.	45	40	40	45	40	25	55	65	30	Do.
Cass loamy fine sand (well drained)	40	30	30	35	30	45	70	75	36	Corn and alfalfa.
O'Neill fine sandy loam	35	30	30	35	30	30	50	60	30	General farming.
Thurman fine sandy loam	30	25	25	30	25	20	40	60	30	Do.
Anselmo fine sandy loam	30	25	25	30	25	20	40	60	30	Corn, rye, and sweetclover.
Colby very fine sandy loam	25	20	20	20	15	15	30	40	28	Pasture.
Colby silt loam	25	20	20	20	15	15	30	40	28	Do.
O'Neill loamy fine sand	20	15	15	20	15	15	35	55	26	Corn, rye, and sweetclover.
Thurman loamy fine sand	20	15	15	20	15	15	35	55	26	Do.
Anselmo loamy fine sand	20	15	15	20	15	15	35	55	26	Do.
Valentine loamy sand	10	10	10	15	10	10	25	40	26	Pasture and wild hay.
Lamoure silt loam (poorly drained)	----	----	----	----	----	----	----	105	45	Do.
Gannett loamy sand	----	----	----	----	----	----	----	105	45	Do.
Cass very fine sandy loam (poorly drained)	----	----	----	----	----	----	----	100	45	Do.
Cass fine sandy loam (poorly drained)	----	----	----	----	----	----	----	100	45	Do.
Cass loamy fine sand (poorly drained)	----	----	----	----	----	----	----	80	40	Do.
Sarpy sand	----	----	----	----	----	----	----	50	23	Do.
Sparta sand	----	----	----	----	----	----	----	40	25	Do.
Rough broken land (Colby soil material)	----	----	----	----	----	----	----	----	26	Pasture.
Valentine fine sand	----	----	----	----	----	----	----	40	23	Pasture and wild hay.
Dune sand	----	----	----	----	----	----	----	30	21	Do.

[1] This table has been prepared jointly by officials of the following organizations: Soil Survey Division, U. S. Bureau of Chemistry and Soils; Land Use Planning Section, U. S. Resettlement Administration; and the Conservation and Survey Division and Agricultural College, University of Nebraska.

[2] The soils are listed in approximate order of their general productivity, the most productive first.

[3] Soil types inherently most productive for the specified crop in the United States are given the index 100. Only those inherently most productive soil types of significant acreage in the more widely known crop regions are given the standard of 100. The other indexes give the approximate production in percent of the standard.

NOTE.—No ratings on grain and tame-hay crops are given to soils that are definitely unsuited to cultivation, although some areas of these soils are farmed.

The rather low indexes given to most of the soils in Garfield County do not necessarily indicate that these soils are poorly suited for the crops grown on them. Some of the soils are among the strongest and most productive in the general region. Few of them give as high yields of any particular crop as are obtained on the ideal, or standard, soil for that crop, but this, in most instances, is due mainly to less favorable moisture conditions, surface features, or both, than occur in areas of the standard soil. The majority of the soils in this county contain enough plant nutrients to insure higher yields if moisture were more abundant.

In rating the soils on the bottom lands or flood plains, two index ratings are given, one applying to the better drained areas and the other to poorly drained areas. The soil map does not distinguish between these areas, except in localities where the drainage is so poor that a marshy condition prevails a part of each year. In such areas, the conventional marsh symbol is used. Elsewhere on the bottom lands the poorly drained tracts, although numerous, occupy such small patches and narrow strips that they cannot be legibly indicated on a map of the scale used in this survey.

Streams occasionally overflow small local tracts on the flood plains, but no special consideration is given to these tracts because overflow is of little importance in the agriculture of the county.

Table 6 is not based on enough of the factors which influence land use to warrant interpreting the ratings directly into specific land values. It is based on essentially permanent factors relating to the inherent productivity of the soils, and no consideration has been given transitory economic factors. In some instances the information on which the ratings are based is not so complete as desired, and further study may suggest changes.

The following tabulation gives the more important crops of the county and the acre-yield that has been set up as a standard of 100 for each crop. These yields represent long-time production averages of the inherently most productive soils of significant acreage in the United States for products of satisfactory quality and are obtained without the use of amendments other than the manure produced on the land.

Crop:	*Bushels*
Corn (grain)	50
Oats	50
Wheat (all kinds)	25
Rye	25
Barley	40
	Pounds
Alfalfa	9,000
Sweetclover	4,000
Wild hay	2,000
	Cow-acre-days [1] *per year*
Pasture	100

[1] "Cow-acre-days" is a term used to express the carrying capacity of pasture land. It is the numerical equivalent of the number of animal units supported by 1 acre during a given number of days.

MORPHOLOGY AND GENESIS OF SOILS

Garfield County is in the Chernozem soil region of the central prairie States. In this region nearly all of the soils have developed under a grass vegetation. They have also developed under a precipitation too low to leach the lime carbonate from the entire soil profile in any of the well-drained and finer textured soils. In such soils, wherever erosion is not severe, carbonates have accumulated in some layer of the solum. The carbonate layer, commonly known as the lime horizon, or lime zone, is more calcareous than any other part of the solum. In this county it does not occur in soils that are severely eroded, are composed largely of sand, or are underlain by sand within a depth of 4 feet.

Most of the soils are immature. The more extensive ones have developed from such extremely sandy and unstable parent materials or have been so severely eroded by wind or water that the normal Chernozem profile is of limited distribution. Most of the soils owe their distinguishing features to the local character of the parent materials and drainage, rather than to the broader environmental influences of the region in which they occur.

All the county, except about 90 square miles of loess-covered land in the southern part, is in the sand-hill section of Nebraska. Here the soils consist mainly of loose quartzitic sand from the surface downward. The more extensive soils are composed almost entirely of this material which has been whipped by the wind into mounds and ridges of various heights. The sand is extremely resistant to weathering, is low in organic matter and lime, and in most places has made but slight progress toward the formation of soil.

The loess-covered part of the county has been little affected by the wind, but most of it, throughout the uplands, has been eroded by water into steep-sided hills and ridges, from which rapid run-off has removed the products of soil development almost as fast as they have formed.

The only areas where conditions have been favorable for deep soil development are in some of the well-drained, level, and protected situations throughout the sand hills; on most of the terraces along the larger streams; and on the more nearly level parts of the loessial uplands, generally the tops of the higher divides. The soils in these areas, which occupy probably less than 15 percent of the county, have formed on parent materials ranging from silts to sands. They have, however, developed under good drainage and have lain in their present positions for long periods, unaffected by alkali, destructive wind or water erosion, or other influences of a strictly local nature. Most of them differ, one from another, rather widely in character, and all are not equally well developed, but all have attained a more advanced stage of development, as determined by the regional climate and vegetation, than any other soils in the county.

The well-drained silty Holdrege and Hall soils of the smoother loessial uplands and terraces, respectively, are the only soils in which all the features common to normal Chernozems are well developed. That is, they are the only soils in which the profile includes a deep dark surface layer and a pronounced horizon of carbonate accumulation and is friable throughout. There are several other soils in the county that have one or two of the features common to normal Chernozems, and all the soils show more or less tendency toward Chernozem development.

Following is a description of a profile of Holdrege silt loam examined on a well-drained smooth-topped divide of the loessial uplands in the southern part of the county. The 18-inch topsoil is very dark, almost black when wet, friable silt loam. The topmost 1½-inch layer is mulchlike or dustlike when dry; the second layer extends to a depth of 5 inches and is faintly laminated; and the rest of the topsoil has a mealy to slightly granular structure. It contains a little more clay and is slightly heavier than the layers above. The next two layers comprise the subsoil. The upper one is dark grayish-brown

silty clay loam 14 inches thick. It is the heaviest layer of the soil profile, but its increased compaction is scarcely noticeable, and the soil material is very friable. On drying it cracks into vertical columns with poorly defined cloddy structure. The lower subsoil layer is the lime horizon. It consists of light grayish-brown or grayish-yellow columnar but otherwise structureless silt containing an abundance of finely divided lime in the form of seams, spots, splotches, fine winding threads, and thin coatings on the surfaces of clods. At a depth of about 6 feet the lime horizon rests on grayish-yellow columnar silt—the parent loess—which is calcareous but has no horizons in which the carbonates are segregated.

The transitions between the different horizons of the profile and between the lime horizon and parent loess are very gradual. The lower part of the topsoil and all underlying layers to the loessial deposit show evidence of insect and worm action.

All the Holdrege and Hall soils have profiles similar to the one described. There are slight differences in the texture, thickness, and composition of the different layers. The Waukesha soils of the terraces and the Marshall soils of the uplands also have profiles similar in a general way to those of the Holdrege soil. Both the Waukesha and Marshall soils, however, have been leached of their lime and in this county have much more sandy subsoils than the Holdrege soils. Most of the Marshall soils are underlain by nearly pure sand within a depth of 4 feet. They have more characteristics of the Prairie than of the Chernozem profile to the top of the sand layer, which does not seem to have entered into the development of the soil.

The Colby soils of this county are very immature. They have developed on loess, similar to that underlying the Holdrege soils, but they are on steep slopes where run-off is rapid and have accumulated very little organic matter. The topsoils are prevailingly thin and are rather light in color. They rest directly on unweathered or only slightly weathered limy loess. These soils are simply eroded phases of the Holdrege soils. At numerous places the topsoil has been entirely removed or has never developed, and the unaltered or only slightly modified parent loess is exposed.

The remaining soils of the uplands and terraces are composed largely of sand, from which all or most of the lime has been leached. The Thurman and O'Neill soils are fairly stable and have made considerable progress in development. They have dark topsoils, owing to an abundance of organic matter, and well-oxidized grayish-brown upper subsoil layers. The lower part of the subsoils consists of loose gray sand. The Thurman soils are on the uplands, and the O'Neill are on the benches. Both are lime free.

The Anselmo soils occur in numerous small areas throughout the sandy uplands. They have developed from mixtures of sand and loess and are fairly coherent. The topsoils have accumulated a little organic matter but not enough to greatly darken them. In most places these soils have been thoroughly leached of their lime, but, here and there, they may contain traces of carbonates in the lower part of the solum.

The Valentine and Sparta soils are low in organic matter and light-colored throughout. They consist almost entirely of sand and

are very unstable if brought under cultivation. None of these soils is calcareous or has definite layers or horizons of true soil character.

The soils on the bottom lands have developed from recently deposited stream sediments. They include the Sarpy and Cass soils on the sandy sediments, and the Lamoure soils on the silts and clays. All these soils are very young and immature. Aside from the Sarpy soil, which is developing on the most recent alluvial deposits, they have accumulated an abundance of organic matter and have very dark topsoils. The subsoils consist of only slightly altered sediments. The sandy soils of the bottom lands may or may not be limy. The finer textured ones are highly calcareous.

SUMMARY

Garfield County is a little northeast of the center of Nebraska. It occupies parts of the loess-hill and sand-hill sections of the State. Although not conspicuous, considerable relief has been produced by stream and wind erosion. The relief of the uplands ranges from rough and broken to nearly level. The smoother areas are on the alluvial lands and in places throughout the uplands where erosion has been least active.

About 90 square miles in the southern part of the county is in the loess section and is mantled to various depths by loose limy light-colored silt. Most of the rest, including more than 80 percent of the total land area, is in the sand-hill section. Alluvial soils occupy about 8 percent of the total land area.

The average elevation of the county is about 2,300 feet above sea level. The general slope is to the south and east. Drainage is effected chiefly through North Loup, Calamus, and Cedar Rivers and their tributaries.

The climate is characterized by high summer and moderate to low winter temperatures. The mean annual precipitation is about 22 inches, and the mean annual temperature is about 47° F.

According to the Federal census, about 27 percent of the county was used for crops in 1929. Most of the remainder was included in pasture land.

The present agriculture consists of a system of combined grain and hay production and livestock raising. The soils of the loessial uplands and terraces are used chiefly for grain crops. The soils of the sandy uplands and terraces, comprising the greater part of the county, together with the areas of rough broken land, are used largely for cattle grazing and the production of hay. Alfalfa is grown mainly on the bottom lands.

The chief crops are corn, oats, rye, barley, wheat, potatoes, and tame hay. As a source of income livestock raising holds first place. It consists chiefly of the grazing and winter fattening of beef cattle and the raising of hogs. During most years livestock and its products have about twice the value of all field crops.

Systematic crop rotation is not practiced, but most farmers change their crops with sufficient regularity to avoid greatly reducing the yields.

The soils of this county differ widely in character and in agricultural adaptation. There are 22 soil types, in addition to dune sand,

rough broken land, and 3 phases of types. These are grouped on the basis of the crops for which they are best suited, as follows: (1) Soils best suited to corn, oats, and wheat; (2) soils best suited to corn, rye, and sweetclover; (3) soils best suited to corn and alfalfa; and (4) soils best suited to native pasture and hay grasses.

The first group includes the Holdrege, Marshall, Waukesha, and Hall soils, all of which have developed from loess. The Holdrege and Marshall occupy upland positions, and the Waukesha and Hall are on terraces. All these soils are well supplied with organic matter and have dark topsoils. They are well drained, have nearly level or gently undulating relief, and are friable throughout. Practically all of the area occupied by them is under cultivation.

The soils to which corn, rye, and sweetclover are best suited include the Thurman and Anselmo soils of the sandy uplands and the O'Neill and Sparta soils of the sandy terraces. The O'Neill and Thurman soils have accumulated considerable organic matter and have dark topsoils, and the Anselmo and Sparta soils contain little organic matter and are light in color. All these soils, owing to their higher sand content, are rather unstable and are less suited for the production of grain than those on which corn, oats, and wheat are most economically grown. They produce fair yields of corn, rye, and sweetclover and are used chiefly for these crops.

The soils on which corn and alfalfa give the largest returns include the Lamoure and Cass soils which are on the bottom lands along the larger streams. These soils contain an abundance of moisture but are well drained, considering their low position. The Cass soils have developed from sandy stream sediments, and the Lamoure are from silty and clayey deposits. Both have accumulated large amounts of well-decayed organic matter in their surface layers which are very dark. These are among the strongest soils in the county for the production of corn and alfalfa.

The soils on which native pasture and hay grasses are most economically produced occupy the greater part of the county. They include dune sand, rough broken land, and the Valentine, Colby, Gannett, and Sarpy soils. The Colby soils and rough broken land are developed on loess. They are subjected to such severe erosion that they are unable to retain much organic matter and are rather light colored from the surface downward. Dune sand and the Valentine soils are composed almost entirely of sand and are rather unstable. The Gannett is the only soil of this group which has accumulated much organic matter. It occupies poorly drained basinlike depressions and cannot be used for the production of grain and tame hay. Sarpy sand is a soil of the bottom lands which is developing on recently deposited sandy sediments under poor drainage conditions. It is light-colored from the surface downward. Most of the area occupied by the soils of this group is in native pasture or hay land.

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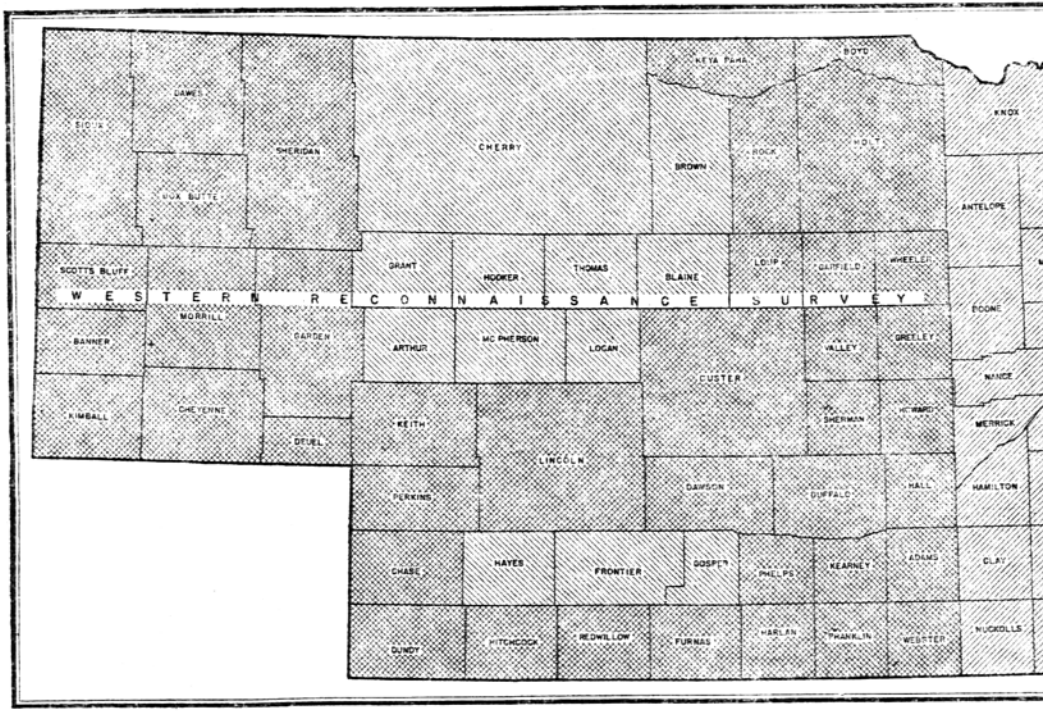
There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than 250 copies shall be for the use of each Senator from the State and not more than 1,000 copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.



Areas surveyed in Nebraska shown by shading. **Detailed surveys** shown by northeast-southwest hatching; re
southeast hatching; cross-hatching indicates areas covered in both w

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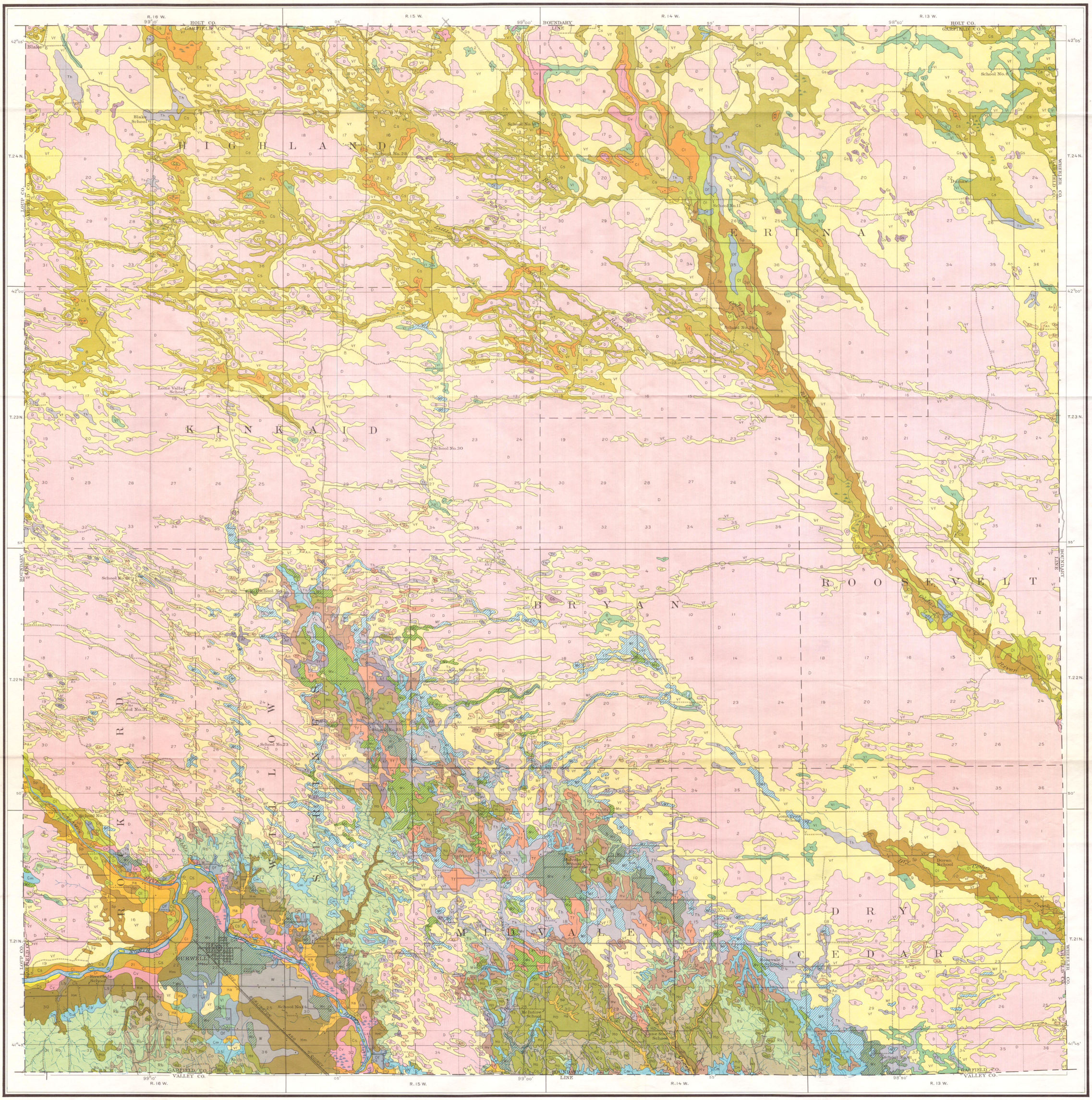
SOIL SURVEY DIVISION, CHARLES E. KELLOGG, CHIEF

SOIL MAP

GARFIELD COUNTY
NEBRASKA

UNIVERSITY OF NEBRASKA
STATE SOIL SURVEY DEPARTMENT OF THE
CONSERVATION AND SURVEY DIVISION
G. E. CONDRA, DEAN AND DIRECTOR



LEGEND

- Anselmo loamy fine sand — An
- Marshall fine sandy loam, Sandy-substratum phase — Mf
- Anselmo fine sandy loam — Af
- Marshall very fine sandy loam, Sandy-substratum phase — Mv
- Cass loamy fine sand — Cs
- O'Neill loamy fine sand — Ol
- Cass fine sandy loam — Cl
- O'Neill fine sandy loam — Or
- Cass very fine sandy loam — Cv
- Sarpy sand — Ss
- Colby very fine sandy loam — Cm
- Sparta sand — Sp
- Colby silt loam — Co
- Thurman loamy fine sand — Th
- Gannett loamy sand — Gs
- Thurman fine sandy loam — Tf
- Hall very fine sandy loam — Ha
- Valentine fine sand — Vf
- Hall silt loam — Hm
- Valentine loamy sand — Vl
- Holdrege very fine sandy loam — Hv
- Waukesha very fine sandy loam, Sandy-substratum phase — Wv
- Holdrege silt loam — Ho
- Waukesha silt loam — W
- Lamoure silt loam — Ls
- Rough broken land (Colby soil material) — Rb
- Dune sand — D

CONVENTIONAL SIGNS

CULTURE

(Printed in black)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort
- Secondary roads and Trails
- Railroads Steam and Electric
- Bridges, Ferry
- R.R. crossings, Tunnel
- Ford, Dam, Sawmill, Windmill
- Boundary lines
- School, Church, Creamery, Cemeteries
- Boundary lines
- Triangulation station Boundary monument Oil or Gas wells
- U.S. Township and Section lines Recovered corners
- Forest fire station Airway beacon Oil or Gas tanks
- Transmission line Oil or Gas pipe line
- Mine or Quarry Rock outcrop Made land
- Soil boundaries, Stony, Gravelly and Cherty areas

DRAINAGE

(Printed in blue)

- Streams, Springs, Wells, Flowing wells
- Lakes, Ponds, Intermittent lakes
- Unsurveyed and Intermittent streams
- Water pipe lines, Canals, Ditches, Flumes
- Swamp Salt marshes
- Submerged marsh Tidal flats

The above signs are in current use on the soil maps. Variations from this design appear in some maps of earlier dates.

Thomas D. Rice, Inspector, District 3.
Soils surveyed by Basil Abaskin, in charge, E. A. Nieschmidt and R. H. Lovald, Nebraska Soil Survey and F. A. Hayes, U. S. Department of Agriculture.

Scale 1 inch-1 mile

1 ½ 0 1 2 3 4 Miles

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Field Operations
Bureau of Chemistry and Soils
1934